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DIANA REFERENCE MANUAL

**Draft Revision 4
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Editors, First Edition

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Preface to the First Edition

This document defines DIANA, an intermediate form of Ada [7] programs that is especially suitable for communication between the Front and Back Ends of Ada compilers. It is based on the Formal Definition of Ada [6] and resulted from the merger of the best aspects of two previous proposals: AIDA [4, 10] and TCOL [2]. Although DIANA is primarily intended as an interface between the parts of a compiler, it is also suitable for other programming support tools and carefully retains the structure of the original source program.

The definition of DIANA given here is expressed in another notation, IDL, that is formally defined in a separate document [9]. The present document is, however, completely self-contained; those aspects of IDL that are needed for the DIANA definition are informally described before they are used. Interested readers should consult the IDL formal description either if they are concerned with either a more precise definition of the notation or if they need to define other data structures in an Ada support environment. In particular, implementors may need to extend DIANA in various ways for use with the tools in a specific environment and the IDL document provides information on how this may be done.

This version of DIANA has been "frozen" to meet the needs of several groups who require a stable definition in a very short timeframe. We invite comments and criticisms for a longer-term review. We expect to re-evaluate DIANA after some practical experience with using it has been accumulated.

Preface To The Second Edition

Since first publication of the DIANA Reference Manual in March, 1981, further developments in connection with Ada and DIANA have required revision of DIANA. These developments include the following:

- o The original DIANA design was based on Ada as defined in the July 1980 Ada Language Reference Manual [7], referred to hereafter as Ada-80; the present revision is based on Ada as defined in the July 1982 Ada LRM [8], referred to hereafter as Ada-82.
- o Experience with use of DIANA has revealed errors and flaws in the original design; these have been corrected.

This publication reflects our best efforts to cope with the conflicting pressures on us both to impact minimally on existing implementations and to create a logically defensible design.

Tartan Laboratories Inc. invites any further comments and criticisms on DIANA in general, and this version of the reference manual in particular. Any correspondence may be sent via ARPANet mail to Diana-Query@USC-ECLB. Paper mail may be sent to

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We believe the changes made to DIANA make no undue constraint on any DIANA users or potential DIANA users, and we wish to hear from those who perceive any of these changes to be a problem.

Preface To This Edition

This is a draft revision of the DIANA Reference Manual.

Experience with DIANA has revealed weaknesses both in the definition of DIANA and in the DIANA Reference Manual. This draft revision incorporates changes in both areas.

Changes to the definition of DIANA include:

- o Overhauling the representation of types and subtypes to accord better with the definition of subtypes in Ada.
- o "Partitioning" the DIANA so that any node or class (except the node void) is directly a member of no more than one class.
- o "Hoisting" attributes to the highest appropriate class.
- o Otherwise regularizing the nomenclature of classes, nodes, and attributes.

Changes to the DIANA Reference Manual include:

- o Separation of semantic specification from rationale.
- o Systematic coverage of static semantics of DIANA.
- o Inclusion of hierarchical diagrams providing a pictorial representation of class-membership relations.
- o Inclusion of several substantial examples.
- o Inclusion of a cross-reference index of nodes and attributes.

Chapter 7, External Representation of DIANA, and Chapter 8, The DIANA Package in Ada, are incomplete in this draft.

Intermetrics, Inc. invites any further comments and criticisms on DIANA in general, and this draft version of the reference manual in particular. Any correspondence may be sent via ARPANet mail to DIANA-QUERY@USC-ISIF. Paper mail may be sent to

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CHAPTER 1
INTRODUCTION

The purpose of standardization is
to aid the creative craftsman, not to
enforce the common mediocrity [11].

1.1 THE DESIGN OF DIANA

In a programming environment such as that envisioned for Ada(1), there will be a number of tools -- formatters (pretty printers), language-oriented editors, cross-reference generators, test-case generators, etc. In general, the input and output of these tools is NOT the source text of the program being developed; instead it is some intermediate form that has been produced by another tool in the environment. This document defines DIANA, **Descriptive Intermediate Attributed Notation for Ada**. DIANA is an intermediate form of Ada programs which has been designed to be especially suitable for communication between two essential tools -- the Front and Back Ends of a compiler -- but also to be suitable for use by other tools in an Ada support environment. DIANA encodes the results of lexical, syntactic and STATIC semantic analysis, but it does NOT include the results of DYNAMIC semantic analysis, of optimization, or of code generation.

DIANA is an abstract data type. The DIANA representation of a particular Ada program is an instance of this abstract type. As with all abstract types, DIANA defines a set of operations that provide the only way in which instances of the type can be examined or modified. The actual data or file structures used to represent the type are hidden by these operations, in the sense that the implementation of a private type in Ada is hidden.

References may be made to a DIANA "tree", "abstract syntax tree", or "attributed parse tree"; similarly, references may be made to "nodes" in these trees. In the context of DIANA as an abstract data type, it is important to appreciate the implications of such terms. This terminology does NOT imply that the data structure used to implement DIANA is necessarily a tree using pointers, etc. Rather, the notion of attributed trees serves as the abstract model for the definition of DIANA.

The following principles governed the original design of DIANA:

- o DIANA should be representation-independent. An effort was made to avoid implying any particular implementation for the DIANA abstract type. Implementation-specific information (such as a value on the target machine) is represented in DIANA by other abstract types which must be supplied by each implementation. In addition, DIANA may be extended or contracted to cater to implementation-specific purposes.
- o DIANA should be suitable for various kinds of processing. Although the primary purpose of DIANA is communication between the Front and Back Ends of compilers, other environment tools should be able to use it as well. The needs of such programs were considered carefully.
- o DIANA should be efficiently implementable. DIANA is intended to be used; hence it was necessary to consider issues such as size and processing speed.
- o The DIANA description and notation should be regular. Consistency in these areas is essential to both understanding and processing.

(1) Ada is a registered trademark of the U.S. Department of Defense.

Although DIANA is representation-independent, there must be at least one form of the DIANA representation that can be communicated between computing systems. Chapter 6 defines an externally visible ASCII form of the DIANA representation of an Ada program. In this form, the DIANA representation can be communicated between arbitrary environment tools and even between arbitrary computing systems. The form may also be useful during the development of the tools themselves.

1.2 THE DEFINITION OF THE DIANA OPERATIONS

Every object of type DIANA is the representation of some specific Ada program (or portion of an Ada program). A minimum set of operations on the DIANA type must provide the ability to:

- o determine the type of a given object (in DIANA terms, the object's node type).
- o obtain the value of a specific attribute of a node.
- o build a node from its constituent parts.
- o determine whether or not a given pair of instances of a DIANA type are in fact the same instance, as opposed to equivalent ones. For the scalar types (Integer and Boolean), no distinction is drawn between equality and equivalence.
- o assign a specific node to a variable, or a specific scalar value to a scalar variable.
- o set the value of an attribute of a given node.

The sequence type Seq Of can be considered as a built-in type that has a few special operators. The operators defined for a sequence type allow an implementation to:

- o create a sequence of a given type
- o determine whether or not a sequence is empty
- o select an element of a sequence
- o add an element to a sequence
- o remove an element from a sequence
- o compare two sequences to see if they are the same sequence
- o assign a sequence to a variable of a sequence type

1.3 THE DEFINITION OF A DIANA USER

Inasmuch as DIANA is an abstract data type, there is no need that it be implemented in any particular way. Additionally, because DIANA is extendable, a particular implementation may choose to use a superset of the DIANA defined in this reference manual. In the face of innumerable variations on the same theme, it is appropriate to offer a definition of what it means to "use" DIANA. Since it makes sense to consider DIANA only at the interfaces, two types of DIANA users are considered: those which "produce" DIANA, and those that "consume" it. These aspects are considered in turn:

o producer

In order for a program to be considered a DIANA producer, it must produce as output a structure that includes all of the information contained in DIANA as defined in this document. Every attribute defined herein must be present, and each attribute must have the value defined for correct DIANA and may not have any other value. This requirement means, for example, that additional values, such as the evaluation of non-static expressions, may not be represented using the DIANA-defined attributes. An implementation is not prevented from defining additional attributes, and in fact it is expected that most DIANA producers will also produce additional attributes.

There is an additional requirement on a DIANA producer: The DIANA structure must have the property that it could have been produced from a legal Ada program. This requirement is likely to impinge most strongly on a tool other than a compiler Front End that produces DIANA. As an example of this requirement, in an arithmetic expression, an offspring of a multiplication could not be an addition but would instead have to be a parenthesized node whose offspring was the addition, since Ada's parsing rules require the parentheses. The motivation for this requirement is to ease the construction of a DIANA consumer, since the task of designing a consumer is completely open-ended unless it can make some reasonable assumptions about its input.

o consumer

In order for a program to be considered a DIANA consumer, it must depend on no more than DIANA as defined herein for the representation of an Ada program. This definition does not prevent a consumer from requiring other kinds of input (such as information about the library, which is not represented in DIANA); however, the DIANA structure must be the only form of representation for an Ada program. This restriction does not prevent a consumer from being able to take advantage of additional attributes that may be defined in an implementation; however, the consumer must also be able to accept input that does not have these additional attributes. It is also incorrect for a program to expect attributes defined herein to have values that are not here specified. For example, it is wrong for a program to expect the attribute sm value to contain values of expressions that are not static.

There are two attributes that are defined herein that are NOT required to be supported by a DIANA user: lx comments and lx srcpos. These attributes are too implementation-specific to be required for all DIANA users.

It should be noted that the definition of a producer and that of a consumer are not mutually exclusive; for example, a compiler Front End that produces DIANA may also read DIANA for separate compilation purposes.

Having defined a DIANA producer and a DIANA consumer, it is now possible to specify the requirements for a DIANA user. It is not proper to claim that a given implementation uses DIANA unless EITHER it meets the following two criteria:

- o It must be able to read and/or write (as appropriate) the external form of DIANA defined in Chapter 6 of this document.
- o The DIANA that is read/written must be either the output of a DIANA producer or suitable input for a DIANA consumer, as specified in this section.

OR it meets this criterion:

- o The implementation provides a package equivalent to that described in Chapter 7.

1.4 THE STRUCTURE OF THIS DOCUMENT

As previously stated, DIANA is an abstract data type that can be modeled as an attributed tree. This document defines both the domain and the operations of this abstract type. The domain of the DIANA type is a subset of the (mathematical) domain known as attributed trees. In order to specify this subset precisely a subset of a notation called IDL [9] is used. A knowledge of IDL is necessary to read or understand this document. Chapter 2 consists of the IDL description of the DIANA domain, organized in the same manner as the Ada Reference Manual. The DIANA operations are described in section 1.2.

Though the IDL description of DIANA may suffice to describe the structure of DIANA, it does not convey the full semantics of that structure. For example, in certain cases the set of allowed values of an attribute may be a subset of the values belonging to the type of the attribute (although the IDL language would permit the definition of a subclass in such cases, to do so would undoubtedly disrupt the hierarchy and cause such a proliferation of subclasses that DIANA would be almost impossible to understand). In addition, the IDL does not specify the instances in which two attributes must denote the same node. Restrictions such as those described above are given in the semantic specification of DIANA, the third chapter of this document.

Chapter 4 is a rationale for the design of DIANA. While the semantic specification is organized according to the class structure of DIANA, the rationale is composed of sections dealing with different semantic concepts which are not necessarily applicable to any one DIANA class.

Chapter 5 contains examples of various kinds of DIANA structures. Each example contains a segment of Ada code and an illustration of the resulting DIANA structure.

Chapter 6 describes the external form of DIANA, an ASCII representation suitable for communication between different computing systems.

Chapter 7 consists of a package specification for the DIANA interface, written in Ada.

Appendix A is a cross-reference guide for the nodes, classes and attributes of DIANA.

Appendix B is a list of references.

1.4.1 NOTATION

To assist the reader in understanding this material, certain typographic and notational conventions are followed consistently throughout this document, as illustrated in Figure 1-1.

DECL	IDL class name
constant_id	IDL node name
<u>sm exp type</u>	IDL attribute
Type	IDL reserved word
"is"	Ada reserved word

Figure 1-1. Typographic and Notational Conventions Used in this Document.

These conventions include:

- o The appearance of class names, node names, and attribute names IN THE TEXT are distinguished by the following typographic conventions: class and node names are bold-faced, and attribute names are underlined. These conventions are not followed in the IDL specification, the diagrams, or the cross-reference guide.
- o Ada reserved words appear in quotes.
- o IDL reserved words appear in lower-case letters, except for the first letter, which is capitalized.
- o Class names appear in all upper-case letters.
- o node names appear in all lower-case letters.
- o attribute names appear in all lower case letters, with one of the prefixes defined below.
- o There are four kinds of attributes defined in DIANA: structural, lexical, semantic, and code. The names of these attributes are lexically distinguished in the definition by the following prefixes:
 - + **as**
Structural attributes define the abstract syntax tree of an Ada program.
 - + **lx**
Lexical attributes provide information about the source form of the program, such as the spelling of identifiers, or position in the source file.
 - + **sm**
Semantic attributes encode the results of semantic analysis -- type and overload resolution, for example.
 - + **cd**
Code attributes provide information from representation specifications that must be observed by the Back End.
- o A class name or node name ending in 's' is always a sequence of what comes before the '_' (if the prefix is extremely long it may be slightly shortened in the sequence name). Thus the reader can be sure on seeing exp_s that the definition

`exp_s => as_list: Seq Of EXP;`

appears somewhere.

- o A class name ending in '_ELEM' contains both the node or class denoted by the prefix of the class name and a node representing a pragma. The name of the node representing the pragma consists of the prefix of the class name and the suffix '_pragma'. Hence the reader knows that for the class name STM_ELEM the following definition exists

`STM_ELEM ::= STM | stm_pragma;`

Throughout the remainder of this document all references to the Ada Reference Manual (ANSI/MIL-STD-1815A-1983) will have the following form: [ARM, section number].

CHAPTER 2
IDL SPECIFICATION

This chapter contains the IDL description of DIANA. It is organized in a manner that parallels the Ada Reference Manual -- each section contains the corresponding segment of Ada syntax along with the related IDL definitions. In some cases a section does not contain any IDL definitions because that particular construct is represented by a node or class which also represents another construct, and the IDL definitions were included in the section pertaining to the other construct. For example, the section covering operators (section 4.5) does not contain IDL definitions because operators in DIANA are represented as function calls, and the related IDL definitions are included in the section on subprogram calls (section 6.4).

Structure Diana
Root compilation Is

-- Private Type Definitions

Type source_position;
Type comments;
Type symbol_rep;
Type value;
Type operator;
Type number_rep;

-- 2. Lexical Elements

-- =====

-- Syntax 2.0

-- has no equivalent in concrete syntax

void => ;

-- 2.3 Identifiers, 2.4 Numeric Literals, 2.6 String Literals

-- Syntax 2.3

-- not of interest for Diana

DEF_NAME ::= SOURCE_NAME | PREDEF_NAME;
DEF_NAME => lx_symrep : symbol_rep;

SOURCE_NAME ::= OBJECT_NAME | TYPE_NAME | UNIT_NAME | LABEL_NAME;
OBJECT_NAME => sm_obj_type : TYPE_SPEC;
UNIT_NAME => sm_first : DEF_NAME;

-- 2.8 Pragmas

-- Syntax 2.8.A

-- pragma ::=

-- pragma identifier [(argument_association {, argument_association})];

pragma => as_used_name_id : used_name_id,
as_general_assoc_s : general_assoc_s;
-- seq of EXP and/or assoc

general_assoc_s => as_list : Seq Of GENERAL_ASSOC;

-- Syntax 2.8.B

-- argument_association ::=

-- [argument_identifier =>] name

```
--      | [argument_identifier =>] expression

-- 3. Declarations and Types
-- =====
-- 3.1 Declarations

-- Syntax 3.1
-- declaration ::=
--      object_declaration      | number_declaration
--      | type_declaration      | subtype_declaration
--      | subprogram_declaration | package_declaration
--      | task_declaration      | generic_declaration
--      | exception_declaration | generic_instantiation
--      | renaming_declaration  | deferred_constant_declaration

DECL ::=          ID_S_DECL | ID_DECL;

ID_DECL ::=       type_decl
                  | subtype_decl
                  | task_decl
                  | UNIT_DECL;

ID_DECL =>        as_source_name : SOURCE_NAME;

ID_S_DECL ::=     EXP_DECL
                  | exception_decl
                  | deferred_constant_decl;

ID_S_DECL =>      as_source_name_s : source_name_s;

EXP_DECL ::=      OBJECT_DECL
                  | number_decl;

EXP_DECL =>       as_exp : EXP;

-- 3.2 Objects and Named Numbers

-- Syntax 3.2.A
-- object_declaration ::=
--      identifier_list : [constant] subtype_indication [:= expression];
--      | identifier_list : [constant] constrained_array_definition [:= expression]

EXP ::=           void;

CONSTRAINED_DEF ::= subtype_indication;

OBJECT_DECL ::=   constant_decl | variable_decl;
OBJECT_DECL =>   as_type_def : TYPE_DEF;

constant_decl => ;
variable_decl => ;
```

```
OBJECT_NAME ::=      INIT_OBJECT_NAME;

INIT_OBJECT_NAME ::= VC_NAME;
INIT_OBJECT_NAME =>  sm_init_exp : EXP;

VC_NAME ::=          variable_id | constant_id;
VC_NAME =>           sm_renames_obj : Boolean,
                    sm_address : EXP; -- EXP or void

variable_id =>       sm_is_shared : Boolean;

constant_id =>       sm_first : DEF_NAME;

-- Syntax 3.2.B
-- number_declaration ::=
--   identifier_list : constant := universal_static_expression;

number_decl => ;

INIT_OBJECT_NAME ::=  number_id;

number_id => ;

-- Syntax 3.2.C
-- identifier_list ::= identifier {, identifier}

source_name_s =>      as_list : Seq Of SOURCE_NAME;

-- 3.3 Types and Subtypes
-- 3.3.1 Type Declarations

-- Syntax 3.3.1.A
-- type_declaration ::= full_type_declaration
--   | incomplete_type_declaration | private_type_declaration
--
-- full_type_declaration ::=
--   type identifier [discriminant_part] is type_definition;
--
--
-- type_decl =>         as_dscrmt_decl_s : dscrmt_decl_s,
--                    as_type_def : TYPE_DEF;

TYPE_NAME ::=         type_id;
TYPE_NAME =>          sm_type_spec : TYPE_SPEC;

type_id =>            sm_first : DEF_NAME;

-- Syntax 3.3.1.B
-- type_definition ::=
```

```
-- enumeration_type_definition | integer_type_definition
-- | real_type_definition      | array_type_definition
-- | record_type_definition    | access_type_definition
-- | derived_type_definition
```

```
TYPE_DEF ::=
    enumeration_def
    | CONSTRAINED_DEF
    | ARR_ACC_DER_DEF
    | record_def;
```

```
CONSTRAINED_DEF ::=
    integer_def
    | float_def
    | fixed_def;
```

```
ARR_ACC_DER_DEF ::=
    constrained_array_def
    | unconstrained_array_def
    | access_def
    | derived_def;
```

```
ARR_ACC_DER_DEF => as_subtype_indication : subtype_indication;
```

```
TYPE_SPEC ::= DERIVABLE_SPEC;
```

```
DERIVABLE_SPEC ::= FULL_TYPE_SPEC | PRIVATE_SPEC;
DERIVABLE_SPEC => sm_derived : TYPE_SPEC,
                  sm_is_anonymous : Boolean;
```

```
FULL_TYPE_SPEC ::= task_spec | NON_TASK;
```

```
NON_TASK ::= SCALAR | UNCONSTRAINED | CONSTRAINED;
NON_TASK => sm_base_type : TYPE_SPEC;
```

```
SCALAR ::= enumeration | integer | REAL;
SCALAR => sm_range : RANGE;
SCALAR => cd_impl_size : Integer;
```

```
REAL ::= float | fixed;
REAL => sm_accuracy : value;
```

```
UNCONSTRAINED ::= UNCONSTRAINED_COMPOSITE | access;
UNCONSTRAINED => sm_size : EXP; -- EXP or void
```

```
UNCONSTRAINED_COMPOSITE ::= array | record;
UNCONSTRAINED_COMPOSITE => sm_is_limited : Boolean,
                           sm_is_packed : Boolean;
```

```
CONSTRAINED ::= constrained_array
               | constrained_record
               | constrained_access;
CONSTRAINED => sm_depends_on_dscmt : Boolean;
```

-- 3.3.2 Subtype Declarations

-- Syntax 3.3.2.A

```
-- subtype_declaration ::= subtype identifier is subtype_indication;
    subtype_decl =>          as_subtype_indication : subtype_indication;
    TYPE_NAME ::=            subtype_id;
    subtype_id => ;
```

-- Syntax 3.3.2.B

```
-- subtype_indication ::= type_mark [constraint]
--
-- type_mark ::= type_name | subtype_name

    CONSTRAINT ::=          void;
    CONSTRAINED_DEF =>      as_constraint : CONSTRAINT;
    subtype_indication =>   as_name : NAME;
```

-- Syntax 3.3.2.C

```
-- constraint ::=
--     range_constraint | floating_point_constraint | fixed_point_constraint
--     | index_constraint | discriminant_constraint

    CONSTRAINT ::=          DISCRETE_RANGE
                           | REAL_CONSTRAINT
                           | index_constraint
                           | discrmt_constraint;
```

-- 3.4 Derived Type Definitions

-- Syntax 3.4

```
-- derived_type_definition ::= new subtype_indication
    derived_def => ;
```

-- 3.5 Scalar Types

-- Syntax 3.5

```
-- range_constraint ::= range range
--
-- range ::= range_attribute
--     | simple_expression .. simple_expression
```

```
    DISCRETE_RANGE ::=      RANGE
```



```

                                | discrete_subtype;

RANGE ::=                      range | range_attribute | void;
RANGE =>                        sm_type_spec : TYPE_SPEC;

range =>                        as_exp1 : EXP,
                                as_exp2 : EXP;

range_attribute =>             as_name : NAME,
                                as_used_name_id : used_name_id,
                                as_exp : EXP; -- EXP or void

-- 3.5.1 Enumeration Types

-- Syntax 3.5.1.A
-- enumeration_type_definition ::=
--     (enumeration_literal_specification {, enumeration_literal_specification}

enumeration_def =>             as_enum_literal_s : enum_literal_s;

enum_literal_s =>              as_list : Seq Of ENUM_LITERAL;

enumeration =>                 sm_literal_s : enum_literal_s;

-- Syntax 3.5.1.B
-- enumeration_literal_specification ::= enumeration_literal
-- enumeration_literal ::= identifier | character_literal

OBJECT_NAME ::=               ENUM_LITERAL;

ENUM_LITERAL ::=              enumeration_id | character_id;

ENUM_LITERAL =>                sm_pos : Integer,
                                sm_rep : Integer;

enumeration_id => ;
character_id => ;

-- 3.5.4 Integer Types

-- Syntax 3.5.4
-- integer_type_definition ::= range_constraint

integer_def => ;

integer => ;

-- 3.5.6 Real Types
```

```
-- Syntax 3.5.6
-- real_type_definition ::=
--   floating_point_constraint | fixed_point_constraint
```

```
REAL_CONSTRAINT ::=      float_constraint
                        | fixed_constraint;
```

```
REAL_CONSTRAINT =>      sm_type_spec : TYPE_SPEC;
```

-- 3.5.7 Floating Point Types

```
-- Syntax 3.5.7
-- floating_point_constraint ::=
--   floating_accuracy_definition [range_constraint]
-- floating_accuracy_definition ::= digits static_simple_expression
```

```
float_def => ;
```

```
REAL_CONSTRAINT =>      as_exp : EXP,
                        as_range : RANGE;
```

```
float_constraint => ;
```

```
float => ;
```

-- 3.5.9 Fixed Point Types

```
-- Syntax 3.5.9
-- fixed_point_constraint ::=
--   fixed_accuracy_definition [range_constraint]
-- fixed_accuracy_definition ::= delta static_simple_expression
```

```
fixed_def => ;
```

```
fixed_constraint => ;
```

```
fixed =>      cd_impl_small : value;
```

-- 3.6 Array Types

```
-- Syntax 3.6.A
-- array_type_definition ::=
--   unconstrained_array_definition | constrained_array_definition
-- unconstrained_array_definition ::=
--   array(index_subtype_definition {, index_subtype_definition}) of
--     component_subtype_indication
```

```
-- constrained_array_definition ::=
--   array index_constraint of component_subtype_indication

constrained_array_def => as_constraint : CONSTRAINT;
index_constraint =>      as_discrete_range_s : discrete_range_s;
discrete_range_s =>      as_list : Seq Of DISCRETE_RANGE;
unconstrained_array_def => as_index_s : index_s;
scalar_s =>              as_list : Seq Of SCALAR;
array =>                 sm_index_s : index_s,
                        sm_comp_type : TYPE_SPEC;
constrained_array =>      sm_index_subtype_s : scalar_s;

-- Syntax 3.6.B
-- index_subtype_definition ::= type_mark range <>

index =>                 as_name : NAME,
                        sm_type_spec : TYPE_SPEC;
index_s =>               as_list : Seq Of index;

-- Syntax 3.6.C
-- index_constraint ::= (discrete_range {, discrete_range})
-- discrete_range ::= discrete_subtype_indication | range
discrete_subtype =>      as_subtype_indication : subtype_indication;

-- 3.7 Record Types

-- Syntax 3.7.A
-- record_type_definition ::=
--   record
--     component_list
--   end record

REP ::=                  void;
record_def =>            as_comp_list : comp_list;
record =>                sm_discriminant_s : dscrmt_decl_s,
                        sm_comp_list : comp_list,
```

```

                                sm_representation : REP; -- REP or void

constrained_record => sm_normalized_dscrmt_s : exp_s;

-- Syntax 3.7.B
-- component_list ::=
--     component_declaration {component_declaration}
--     | {component_declaration} variant_part
--     | null;

-- component_declaration ::=
--     identifier_list : component_subtype_definition [:= expression];

-- component_subtype_definition ::= subtype_indication

DECL ::=
                                null_comp_decl;

INIT_OBJECT_NAME ::= COMP_NAME;
COMP_NAME ::=
                                component_id | discriminant_id;

COMP_NAME =>
                                sm_comp_rep : COMP_REP_ELEM;

component_id => ;

-- 3.7.1 Discriminants

-- Syntax 3.7.1
-- discriminant_part ::=
--     (discriminant_specification {; discriminant_specification})

-- discriminant_specification ::=
--     identifier_list : type_mark [:= expression]

ITEM ::=
                                DSCRMT_PARAM_DECL;

DSCRMT_PARAM_DECL ::= dscrmt_decl;

DSCRMT_PARAM_DECL =>
                                as_source_name_s : source_name_s,
                                as_name : NAME,
                                as_exp : EXP;

dscrmt_decl_s =>
                                as_list : Seq Of dscrmt_decl;

dscrmt_decl => ;

discriminant_id =>
                                sm_first : DEF_NAME;

-- 3.7.2 Discriminant Constraints
```

```
-- Syntax 3.7.2
-- discriminant_constraint ::=
--   (discriminant_association {, discriminant_association})
-- discriminant_association ::=
--   [discriminant_simple_name { | discriminant_simple_name } =>] expression
```

```
    dscrmnt_constraint =>    as_general_assoc_s : general_assoc_s;
```

-- 3.7.3 Variant Parts

```
-- Syntax 3.7.3.A
-- variant_part ::=
--   case discriminant_simple_name is
--     variant
--     {variant}
--   end case;
-- variant ::=
--   when choice { | choice } =>
--     component_list
```

```
VARIANT_PART ::=      variant_part | void;
variant_part =>        as_name : NAME,
                      as_variant_s : variant_s;
variant_s =>           as_list : Seq Of VARIANT_ELEM;
VARIANT_ELEM ::=      variant | variant_pragma;
variant =>             as_choice_s : choice_s,
                      as_comp_list : comp_list;
choice_s =>            as_list : Seq Of CHOICE;
comp_list =>           as_decl_s : decl_s,
                      as_variant_part : VARIANT_PART,
                      as_pragma_s : pragma_s;
variant_pragma =>      as_pragma : pragma;
```

```
-- Syntax 3.7.3.B
-- choice ::= simple_expression
--   | discrete_range | others | component_simple_name
```

```
CHOICE ::=            choice_exp | choice_range | choice_others;
choice_exp =>          as_exp : EXP;
```

```

choice_range =>          as_discrete_range : DISCRETE_RANGE;
choice_others => ;

-- 3.8 Access Types
-- Syntax 3.8
-- access_type_definition ::= access subtype_indication
access_def => ;

access =>
    sm_storage_size : EXP, -- EXP or void
    sm_is_controlled : Boolean,
    sm_desig_type : TYPE_SPEC,
    sm_master : ALL_DECL;

constrained_access => sm_desig_type : TYPE_SPEC;

-- 3.8.1 Incomplete Type Declarations
-- Syntax 3.8.1
-- incomplete_type_declaration ::= type identifier [discriminant_part];
TYPE_DEF ::=
    void;
TYPE_SPEC ::=
    incomplete;
incomplete =>
    sm_discriminant_s : dscrmt_decl_s;
TYPE_SPEC ::=
    void;

-- 3.9 Declarative Parts
-- Syntax 3.9.A
-- declarative_part ::=
--     {basic_declarative_item} {later_declarative_item}
-- basic_declarative_item ::= basic_declaration
--     | representation_clause | use_clause
DECL ::=
    REP;
DECL ::=
    USE_PRAGMA;
USE_PRAGMA ::=
    use | pragma;

-- Syntax 3.9.B
-- later_declarative_item ::= body
--     | subprogram_declaration | package_declaration

```

```
--      | task_declaration      | generic_declaration
--      | use_clause            | generic_instantiation

-- body ::= proper_body | stub

-- proper_body ::= subprogram_body | package_body | task_body

ITEM ::=          DECL | SUBUNIT_BODY;

item_s =>         as_list : Seq Of ITEM;

UNIT_DECL ::=     generic_decl
                  | NON_GENERIC_DECL;

UNIT_DECL =>      as_header : HEADER;

NON_GENERIC_DECL ::= subprog_entry_decl
                    | package_decl;

NON_GENERIC_DECL => as_unit_kind : UNIT_KIND;

-- 4. Names and Expressions
-- =====
-- 4.1 Names

-- Syntax 4.1.A
-- name ::= simple_name
--      | character_literal | operator_symbol
--      | indexed_component | slice
--      | selected_component | attribute

-- simple_name ::= identifier

NAME ::=          DESIGNATOR
              | NAME_EXP;

NAME_EXP ::=      NAME_VAL
              | indexed
              | slice
              | all;

NAME_EXP =>       as_name : NAME;
NAME_EXP =>       sm_exp_type : TYPE_SPEC;

NAME_VAL ::=      attribute
              | selected;

NAME_VAL =>       sm_value : value;

DESIGNATOR ::=    USED_OBJECT | USED_NAME;
DESIGNATOR =>     sm_defn : DEF_NAME,
                  lx_symrep : symbol_rep;

USED_NAME ::=     used_op | used_name_id;
```

```
    used_op => ;
    used_name_id => ;

    USED_OBJECT ::=      used_char | used_object_id;
    USED_OBJECT =>      sm_exp_type : TYPE_SPEC,
                       sm_value : value;

    used_char => ;
    used_object_id =>;

-- Syntax 4.1.B
-- prefix ::= name | function_call

    NAME_VAL ::=      function_call;

-- 4.1.1 Indexed Components

-- Syntax 4.1.1
-- indexed_component ::= prefix(expression {, expression})

    exp_s =>          as_list : Seq Of EXP;
    indexed =>        as_exp_s : exp_s;

-- 4.1.2 Slices

-- Syntax 4.1.2
-- slice ::= prefix(discrete_range)

    slice =>          as_discrete_range : DISCRETE_RANGE;

-- 4.1.3 Selected Components

-- Syntax 4.1.3
-- selected_component ::= prefix.selector

-- selector ::= simple_name
--               | character_literal | operator_symbol | all

    selected =>        as_designator : DESIGNATOR;
    all => ;

-- 4.1.4 Attributes

-- Syntax 4.1.4
-- attribute ::= prefix'attribute_designator

-- attribute_designator ::= simple_name [(universal_static_expression)]
```



```
attribute =>          as_used_name_id : used_name_id,  
                      as_exp : EXP;
```

-- 4.2 Literals

-- 4.3 Aggregates

-- Syntax 4.3.A

```
-- aggregate ::=  
--   (component_association {, component_association})
```

```
aggregate =>          as_general_assoc_s : general_assoc_s;  
aggregate =>          sm_normalized_comp_s : general_assoc_s;
```

-- Syntax 4.3.B

```
-- component_association ::=  
--   [choice { | choice } => ] expression
```

```
GENERAL_ASSOC ::=      NAMED_ASSOC | EXP;  
  
NAMED_ASSOC ::=        named;  
NAMED_ASSOC =>         as_exp : EXP;  
  
named =>               as_choice_s : choice_s;
```

-- 4.4 Expressions

-- Syntax 4.4.A

```
-- expression ::=  
--   relation {and relation} | relation {and then relation}  
--   | relation {or relation} | relation {or else relation}  
--   | relation {xor relation}
```

```
EXP_VAL ::=            short_circuit;  
  
short_circuit =>       as_exp1 : EXP,  
                      as_short_circuit_op : SHORT_CIRCUIT_OP,  
                      as_exp2 : EXP;  
  
SHORT_CIRCUIT_OP ::=   and_then | or_else;  
  
and_then => ;  
or_else  => ;
```

-- Syntax 4.4.B

```
-- relation ::=  
--   simple_expression [relational_operator simple_expression]
```

```
-- | simple_expression [not] in range
-- | simple_expression [not] in type_mark
```

```
EXP_VAL_EXP ::=      MEMBERSHIP;

MEMBERSHIP ::=      range_membership | type_membership;
MEMBERSHIP =>      as_membership_op : MEMBERSHIP_OP;

range_membership =>  as_range : RANGE;

type_membership =>   as_name : NAME;

MEMBERSHIP_OP ::=    in_op | not_in;

in_op => ;
not_in => ;
```

```
-- Syntax 4.4.C
-- simple_expression ::=
--   [unary_operator] term {binary_adding_operator term}

-- term ::= factor {multiplying_operator factor}

-- factor ::= primary [ primary ] | abs primary | not primary
```

```
-- Syntax 4.4.D
-- primary ::=
--   numeric_literal | null | aggregate | string_literal | name | allocator
--   | function_call | type_conversion | qualified_expression | (expression)
```

```
EXP ::=
    NAME
  | EXP_EXP;

EXP_EXP ::=
    EXP_VAL
  | AGG_EXP
  | qualified_allocator
  | subtype_allocator;
EXP_EXP =>
    sm_exp_type : TYPE_SPEC;

EXP_VAL ::=
    numeric_literal
  | null_access
  | EXP_VAL_EXP;
EXP_VAL =>
    sm_value : value;

EXP_VAL_EXP ::=
    QUAL_CONV
  | parenthesized;
EXP_VAL_EXP =>
    as_exp : EXP;

AGG_EXP ::=
    aggregate
  | string_literal;
```

```

    AGG_EXP =>          sm_discrete_range : DISCRETE_RANGE;

    parenthesized => ;

    numeric_literal =>    lx_numrep : number_rep;

    string_literal =>     lx_symrep : symbol_rep;

    null_access => ;

-- 4.5 Operators and Expression Evaluation

-- Syntax 4.5
-- logical_operator ::= and | or | xor

-- relational_operator ::= = | /= | < | <= | > | >=

-- adding_operator ::= + | - | &

-- unary_operator ::= + | -

-- multiplying_operator ::= * | / | mod | rem

-- highest_precedence_operator ::= ** | abs | not

-- 4.6 Type Conversions

-- Syntax 4.6
-- type_conversion ::= type_mark(expression)

    QUAL_CONV ::=      conversion
                    | qualified;
    QUAL_CONV =>        as_name : NAME;

    conversion =>;

-- 4.7 Qualified Expressions

-- Syntax 4.7
-- qualified_expression ::=
--     type_mark'(expression) | type_mark'aggregate

    qualified => ;

-- 4.8 Allocators

-- Syntax 4.8
-- allocator ::=
--     new subtype_indication | new qualified_expression

    qualified_allocator => as_qualified : qualified;

```

```
subtype_allocator =>  as_subtype_indication : subtype_indication,  
                      sm_design_type : TYPE_SPEC;
```

-- 5. Statements

-- =====

-- 5.1 Simple and Compound Statements - Sequences of Statements

-- Syntax 5.1.A

-- sequence_of_statements ::= statement {statement}

```
STM_ELEM ::=          STM | stm_pragma;
```

```
stm_s =>              as_list : Seq Of STM_ELEM;
```

```
stm_pragma =>         as_pragma : pragma;
```

-- Syntax 5.1.B

-- statement ::=

-- {label} simple_statement | {label} compound_statement

```
STM ::=              labeled;
```

```
labeled =>           as_source_name_s : source_name_s,  
                    as_pragma_s : pragma_s,  
                    as_stm : STM;
```

-- Syntax 5.1.C

-- simple_statement ::= null_statement

-- | assignment_statement | procedure_call_statement

-- | exit_statement | return_statement

-- | goto_statement | entry_call_statement

-- | delay_statement | abort_statement

-- | raise_statement | code_statement

```
STM ::=              null_stm  
                    | abort;
```

```
STM ::=              STM_WITH_EXP;
```

```
STM_WITH_EXP ::=     return  
                    | delay;
```

```
STM_WITH_EXP ::=     STM_WITH_EXP_NAME;
```

```
STM_WITH_EXP =>      as_exp : EXP;
```

```
STM_WITH_EXP_NAME ::= assign
```

```

                                | exit
                                | code;

STM_WITH_EXP_NAME =>   as_name : NAME;

STM ::=
                        STM_WITH_NAME;

STM_WITH_NAME ::=
                        goto
                        | raise;

STM_WITH_NAME ::=      CALL_STM;
CALL_STM ::=           entry_call
                        | procedure_call;

STM_WITH_NAME =>       as_name : NAME;

-- Syntax 5.1.D
-- compound_statement ::=
--     if_statement      | case_statement
--     | loop_statement  | block_statement
--     | accept_statement | select_statement

STM ::=
                        accept
                        | BLOCK_LOOP
                        | ENTRY_STM;

STM_WITH_EXP ::=      case;

STM ::=
                        CLAUSES_STM;

CLAUSES_STM ::=
                        if
                        | selective_wait;

CLAUSES_STM =>
                        as_test_clause_elem_s : test_clause_elem_s,
                        as_stm_s : stm_s;

-- Syntax 5.1.E
-- label ::= <<label_simple_name>>

LABEL_NAME ::=         label_id;
LABEL_NAME =>          sm_stm : STM;

label_id => ;

-- Syntax 5.1.F
-- null_statement ::= null ;

null_stm => ;

-- 5.2 Assignment Statement

```

```
-- Syntax 5.2
-- assignment_statement ::=
--     variable_name := expression;

    assign => ;

-- 5.3 If Statements

-- Syntax 5.3.A
-- if_statement ::=
--     if condition then
--         sequence_of_statements
--     {elseif condition then
--         sequence_of_statements}
--     [else
--         sequence_of_statements]
--     end if;

    if => ;

TEST_CLAUSE ::=      cond_clause;
TEST_CLAUSE =>      as_exp : EXP,
                    as_stm_s : stm_s;

    cond_clause => ;

-- Syntax 5.3.B
-- condition ::= boolean_expression

-- 5.4 Case Statements

-- Syntax 5.4
-- case_statement ::=
--     case expression is
--         case_statement_alternative
--     {case_statement_alternative}
--     end case;

-- case_statement_alternative ::=
--     when choice { | choice } =>
--         sequence_of_statements}

ALTERNATIVE_ELEM ::=  alternative | alternative_pragma;

case =>                as_alternative_s : alternative_s;

alternative_s =>       as_list : Seq Of ALTERNATIVE_ELEM;

alternative =>         as_choice_s : choice_s,
                    as_stm_s : stm_s;
```

alternative_pragma => as_pragma : pragma;

-- 5.5 Loop Statements

-- Syntax 5.5.A

```
-- loop_statement ::=
--   [loop_simple_name:]
--   [iteration_scheme] loop
--   sequence_of_statements
--   end loop [loop_simple_name];
```

BLOCK_LOOP ::= loop;

BLOCK_LOOP => as_source_name : SOURCE_NAME;

SOURCE_NAME ::= void;

LABEL_NAME ::= block_loop_id;

block_loop_id => ;

ITERATION ::= void;

loop => as_iteration : ITERATION,
as_stm_s : stm_s;

-- Syntax 5.5.B

```
-- iteration_scheme ::= while condition
--   | for loop_parameter_specification
--
-- loop_parameter_specification ::=
--   identifier in [reverse] discrete_range
```

ITERATION ::= FOR_REV;
FOR_REV ::= for | reverse;
FOR_REV => as_source_name : SOURCE_NAME,
as_discrete_range : DISCRETE_RANGE;

for => ;
reverse => ;

OBJECT_NAME ::= iteration_id;
iteration_id => ;

ITERATION ::= while;
while => as_exp : EXP;

-- 5.6 Block Statements

-- Syntax 5.6

```
-- block_statement ::=
--   [block_simple_name:]
--   [declare
--     declarative_part]
--   begin
--     sequence_of_statements
--   [exception
--     exception_handler
--     {exception_handler}]
--   end [block_simple_name];
```

```
BLOCK_LOOP ::=      block;
```

```
block =>             as_block_body : block_body;
```

```
block_body =>        as_item_s : item_s,
                    as_stm_s : stm_s,
                    as_alternative_s : alternative_s;
```

-- 5.7 Exit Statements

-- Syntax 5.7

```
-- exit_statement ::=
--   exit [loop_name] [when condition];
```

```
NAME ::=            void;
```

```
exit =>             sm_stm : STM;
```

-- 5.8 Return Statements

-- Syntax 5.8

```
-- return_statement ::= return [expression];
```

```
return => ;
```

-- 5.9 Goto Statements

-- Syntax 5.9

```
-- goto_statement ::= goto label_name;
```

```
goto => ;
```

-- 6. Subprograms

```
-- =====
```

-- 6.1 Subprogram Declarations

-- Syntax 6.1.A

-- subprogram_declaration ::= subprogram_specification;

subprog_entry_decl => ;

UNIT_NAME ::= NON_TASK_NAME;

NON_TASK_NAME ::= SUBPROG_PACK_NAME;
NON_TASK_NAME => sm_spec : HEADER;

SUBPROG_PACK_NAME ::= SUBPROG_NAME;
SUBPROG_PACK_NAME => sm_unit_desc : UNIT_DESC,
sm_address : EXP;

SUBPROG_NAME ::= procedure_id | function_id | operator_id;
SUBPROG_NAME => sm_is_inline : Boolean,
sm_interface : PREDEF_NAME;

UNIT_DESC ::= UNIT_KIND | BODY
| implicit_not_eq | derived_subprog;

UNIT_KIND ::= void;

derived_subprog => sm_derivable : SOURCE_NAME;

implicit_not_eq => sm_equal : SOURCE_NAME;

procedure_id => ;
function_id => ;
operator_id => ;

-- Syntax 6.1.B

-- subprogram_specification ::=
-- procedure identifier [formal_part]
-- | function designator [formal_part] return type_mark

-- designator ::= identifier | operator_symbol

-- operator_symbol ::= string_literal

HEADER ::= SUBP_ENTRY_HEADER;

SUBP_ENTRY_HEADER ::= procedure_spec | function_spec;

SUBP_ENTRY_HEADER => as_param_s : param_s;

procedure_spec => ;

function_spec => as_name : NAME;

```
-- Syntax 6.1.C
-- formal_part ::=
--   (parameter_specification {; parameter_specification})

-- parameter_specification ::=
--   identifier_list : mode type_mark [:= expression]

-- mode ::= [in] | in out | out
```

```
param_s =>          as_list : Seq Of PARAM;

DESCRMT_PARAM_DECL ::= PARAM;

PARAM ::=           in | out | in_out;

in =>               lx_default : Boolean;
in_out => ;
out => ;

INIT_OBJECT_NAME ::= PARAM_NAME;

PARAM_NAME ::=      in_id | in_out_id | out_id;
PARAM_NAME =>       sm_first : DEF_NAME;

in_id => ;
in_out_id => ;
out_id => ;
```

-- 6.3 Subprogram Bodies

```
-- Syntax 6.3
-- subprogram_body ::=
--   subprogram_specification is
--     [declarative_part]
--   begin
--     sequence_of_statements
--   [exception
--     exception_handler
--     {exception_handler}]
--   end [designator];
```

```
BODY ::=           block_body | stub | void;

subprogram_body =>  as_header : HEADER;
```

-- 6.4 Subprogram Calls

```
-- Syntax 6.4
-- procedure_call_statement ::=
```

```
--      procedure_name [actual_parameter_part];
--
--      function_call ::=
--          function_name [actual_parameter_part]
--
--      actual_parameter_part ::=
--          (parameter_association {, parameter_association})
--
--      parameter_association ::=
--          [formal_parameter =>] actual_parameter
--
--      formal_parameter ::= parameter_simple_name
--
--      actual_parameter ::=
--          expression | variable_name | type_mark(variable_name)
--
--
--      CALL_STM =>          as_general_assoc_s : general_assoc_s;
--      CALL_STM =>          sm_normalized_param_s : exp_s;
--
--      procedure_call => ;
--
--      function_call =>      as_general_assoc_s : general_assoc_s;
--      function_call =>      sm_normalized_param_s : exp_s;
--      function_call =>      lx_prefix : Boolean;
--
--      NAMED_ASSOC ::=      assoc;
--
--      assoc =>              as_used_name : USED_NAME;
--
--
-- 7. Packages
-- =====
-- 7.1 Package Structure
--
-- Syntax 7.1.A
-- package_declaration ::= package_specification;
--
--      package_decl => ;
--
--      SUBPROG_PACK_NAME ::= package_id;
--
--      package_id => ;
--
--
-- Syntax 7.1.B
-- package_specification ::=
--     package_identifier is
--         {basic_declarative_item}
--     [private
--         {basic_declarative_item}]
--     end [package_simple_name]
```

```

package_spec =>      as_decl_s1 : decl_s,
                     as_decl_s2 : decl_s;

decl_s =>            as_list : Seq Of DECL;

-- Syntax 7.1.C
-- package_body ::=
--     package body package_simple_name is
--         [declarative_part]
--     [begin
--         sequence_of_statements
--     [exception
--         exception_handler
--         {exception_handler}}}
--     end [package_simple_name];

package_body =>      ;

-- 7.4 Private Type and Deferred Constant Declarations

-- Syntax 7.4.A
-- private_type_declaration ::=
--     type_identifier [discriminant_part] is [limited] private;

TYPE_DEF ::=        private_def | l_private_def;

private_def =>      ;
l_private_def =>    ;

TYPE_NAME ::=        private_type_id | l_private_type_id;

private_type_id =>   ;
l_private_type_id => ;

PRIVATE_SPEC ::=      private | l_private;
PRIVATE_SPEC =>      sm_discriminant_s : dscrmt_decl_s,
                     sm_type_spec : TYPE_SPEC;

private =>           ;

l_private =>         ;

-- Syntax 7.4.B
-- deferred_constant_declaration ::=
--     identifier_list : constant type_mark;

deferred_constant_decl => as_name : NAME;

```

-- 8. Visibility Rules

-- =====

-- 8.4 Use Clauses

-- Syntax 8.4

-- use_clause ::= use package_name {, package_name};

use => as_name_s : name_s;

-- 8.5 Renaming Declarations

-- Syntax 8.5

-- renaming_declaration ::=

-- identifier : type_mark renames object_name;

-- | identifier : exception renames exception_name;

-- | package identifier renames package_name;

-- | subprogram_specification renames subprogram_or_entry_name;

ID_DECL ::= SIMPLE_RENAME_DECL;

SIMPLE_RENAME_DECL ::= renames_obj_decl
| renames_exc_decl;

SIMPLE_RENAME_DECL => as_name : NAME;

renames_obj_decl => as_type_mark_name : NAME;

renames_exc_decl => ;

UNIT_KIND ::= RENAME_INSTANT;

RENAME_INSTANT ::= renames_unit;

RENAME_INSTANT => as_name : NAME;

renames_unit => ;

-- 9. Tasks

-- =====

-- 9.1 Task Specifications and Task Bodies

-- Syntax 9.1.A

-- task_declaration ::= task_specification;

--

-- task_specification ::=

-- task [type] identifier [is

-- {entry_declaration}

-- {representation_clause}

-- end [task_simple_name]]

```
task_decl =>          as_decl_s : decl_s;

task_spec =>          sm_decl_s : decl_s,
                      sm_body : BODY,
                      sm_address : EXP,
                      sm_size : EXP,
                      sm_storage_size : EXP;
```

```
-- Syntax 9.1.8
-- task_body ::=
--   task body task_simple_name is
--     [declarative_part]
--   begin
--     sequence_of_statements
--   [exception
--     exception_handler
--     {exception_handler}]
--   end [task_simple_name];
```

```
task_body =>          ;

UNIT_NAME ::=         task_body_id;

task_body_id =>        sm_type_spec : TYPE_SPEC,
                      sm_body : BODY;
```

-- 9.4 Task Dependence - Termination of Tasks

```
ALL_DECL ::=          block_master;

block_master =>        sm_stm : STM;
```

-- 9.5 Entries, Entry Calls and Accept Statements

```
-- Syntax 9.5.A
-- entry_declaration ::=
--   entry identifier [(discrete_range)] [formal_part];
--
```

```
SUBP_ENTRY_HEADER ::= entry;

entry =>               as_discrete_range : DISCRETE_RANGE;

SOURCE_NAME ::=        entry_id;

entry_id =>            sm_spec : HEADER,
                      sm_address : EXP;
```

-- Syntax 9.5.B

```
-- entry_call_statement ::= entry_name [actual_parameter_part];
    entry_call => ;

-- Syntax 9.5.C
-- accept_statement ::=
--     accept entry_simple_name [(entry_index)] [formal_part] [do
--         sequence_of_statements
--     end [entry_simple_name]];
--
-- entry_index ::= expression
    accept =>
        as_name : NAME,
        as_param_s : param_s,
        as_stm_s : stm_s;

-- 9.6 Delay Statements, Duration and Time

-- Syntax 9.6
-- delay_statement ::= delay simple_expression;
    delay => ;

-- 9.7 Select Statements

-- Syntax 9.7
-- select_statement ::= selective_wait
--     | conditional_entry_call | timed_entry_call

-- 9.7.1 Selective Waits

-- Syntax 9.7.1.A
-- selective_wait ::=
--     select
--         select_alternative
--     {or
--         select_alternative}
--     [else
--         sequence_of_statements]
--     end select;

    selective_wait => ;

-- Syntax 9.7.1.B
-- selective_alternative ::=
--     [when condition =>]
--     selective_wait_alternative
```

```
-- selective_wait_alternative ::= accept_alternative
--    | delay_alternative | terminate_alternative

-- accept_alternative ::= accept_statement [sequence_of_statements]

-- delay_alternative ::= delay_statement [sequence_of_statements]

-- terminate_alternative ::= terminate;
```

```
TEST_CLAUSE_ELEM ::= TEST_CLAUSE | select_alt_pragma;

TEST_CLAUSE ::= select_alternative;

test_clause_elem_s => as_list : Seq Of TEST_CLAUSE_ELEM;

select_alternative => ;

select_alt_pragma => as_pragma : pragma;

STM ::= terminate;

terminate => ;
```

-- 9.7.2 Conditional Entry Calls

```
-- Syntax 9.7.2
-- conditional_entry_call ::=
--    select
--        entry_call_statement
--        [sequence_of_statements]
--    else
--        sequence_of_statements
--    end select;
```

```
ENTRY_STM ::= cond_entry | timed_entry;
ENTRY_STM =>
    as_stm_s1 : stm_s,
    as_stm_s2 : stm_s;

cond_entry => ;
```

-- 9.7.3 Timed Entry Calls

```
-- Syntax 9.7.3
-- timed_entry_call ::=
--    select
--        entry_call_statement
--        [sequence_of_statements]
--    or
--        delay_alternative
```



```
--      end select;

      timed_entry => ;

-- 9.10 Abort Statements
-- Syntax 9.10
-- abort_statement ::= abort task_name {, task_name};

      name_s =>          as_list : Seq Of NAME;

      abort =>           as_name_s : name_s;

-- 10. Program Structure and Compilation Issues
-- =====
-- 10.1 Compilation Units - Library Units
-- Syntax 10.1.A
-- compilation ::= {compilation_unit}

      compilation =>      as_compltn_unit_s : compltn_unit_s;
      compltn_unit_s =>    as_list : Seq Of compilation_unit;

-- Syntax 10.1.B
-- compilation_unit ::=
--      context_clause library_unit | context_clause secondary_unit
--      library_unit ::=
--          subprogram_declaration | package_declaration
--          | generic_declaration | generic_instantiation
--          | subprogram_body
--      secondary_unit ::= library_unit_body | subunit
--      library_unit_body ::= subprogram_body | package_body

      ALL_DECL ::=        void;
      pragma_s =>         as_list : Seq Of pragma;
      compilation_unit =>  as_context_elem_s : context_elem_s,
                          as_all_decl : ALL_DECL,
                          as_pragma_s : pragma_s;
      CONTEXT_ELEM ::=    context_pragma;
```

```
context_pragma =>      as_pragma : pragma;

-- Context Clauses - With Clauses
-- Syntax 10.1.1.A
-- context_clause ::= {with_clause {use_clause}}
context_elem_s =>      as_list : Seq Of CONTEXT_ELEM;

-- Syntax 10.1.1.B
-- with_clause ::= with unit_simple_name {, unit_simple_name};

CONTEXT_ELEM ::=      with;
with =>                as_name_s : name_s,
                      as_use_pragma_s : use_pragma_s;
use_pragma_s =>        as_list : Seq Of USE_PRAGMA;

-- 10.2 Subunits of Compilation Units
-- Syntax 10.2.A
-- subunit ::=
--     separate (parent_unit_name) proper_body

subunit =>              as_name : NAME,
                      as_subunit_body : SUBUNIT_BODY;

SUBUNIT_BODY ::=       subprogram_body | package_body | task_body;
SUBUNIT_BODY =>        as_source_name : SOURCE_NAME,
                      as_body : BODY;

-- Syntax 10.2.B
-- body_stub ::=
--     subprogram specification is separate;
--     | package body package_simple_name is separate;
--     | task body task_simple_name is separate;

stub => ;

-- 11. Exceptions
-- =====
-- 11.1 Exception Declarations
-- Syntax 11.1
-- exception_declaration ::= identifier_list : exception;
```

```
exception_decl => ;

SOURCE_NAME ::=      exception_id;

exception_id =>      sm_renames_exc : NAME;

-- 11.2 Exception Handlers

-- Syntax 11.2
-- exception_handler ::=
--     when exception_choice { | exception_choice } =>
--         sequence_of_statements
--
-- exception_choice ::= exception_name | others

-- 11.3 Raise Statements

-- Syntax 11.3
-- raise_statement ::= raise [exception_name];

raise => ;

-- 12. Generic Program Units
-- =====
-- 12.1 Generic Declarations

-- Syntax 12.1.A
-- generic_declaration ::= generic_specification;

-- generic_specification ::=
--     generic_formal_part subprogram_specification
--     | generic_formal_part package_specification

HEADER ::=      package_spec;

generic_decl =>      as_item_s : item_s;

NON_TASK_NAME ::=      generic_id;

generic_id =>      sm_generic_param_s : item_s,
                   sm_body : BODY,
                   sm_is_inline : Boolean;

-- Syntax 12.1.B
-- generic_formal_part ::= generic {generic_parameter_declaration}
```

```
-- Syntax 12.1.C
-- generic_parameter_declaration ::=
--     identifier_list : [in [out]] type_mark [:= expression];
--     | type identifier is generic_type_definition;
--     | private_type_declaration
--     | with subprogram_specification [is name];
--     | with subprogram_specification [is <>];
```

```
UNIT_KIND ::=          GENERIC_PARAM;
```

```
GENERIC_PARAM ::=      name_default
                        | box_default
                        | no_default;
```

```
name_default =>         as_name : NAME;
```

```
box_default => ;
```

```
no_default => ;
```

```
-- Syntax 12.1.D
-- generic_type_definition ::=
--     (<>) | range <> | digits <> | delta <>
--     | array_type_definition | access_type_definition
```

```
TYPE_DEF ::=           formal_dscrt_def
                        | formal_integer_def
                        | formal_fixed_def
                        | formal_float_def;
```

```
formal_dscrt_def => ;
```

```
formal_fixed_def => ;
```

```
formal_float_def => ;
```

```
formal_integer_def => ;
```

-- 12.3 Generic Instantiation

```
-- Syntax 12.3.A
-- generic_instantiation ::=
--     package identifier is
--         new generic_package_name [generic_actual_part];
--     | procedure identifier is
--         new generic_procedure_name [generic_actual_part];
--     | function identifier is
--         new generic_function_name [generic_actual_part];
```

```
-- generic_actual_part ::=
--     (generic_association {, generic_association})
```

```

    RENAME_INSTANT ::=      instantiation;

    instantiation =>        as_general_assoc_s : general_assoc_s;
    instantiation =>        sm_decl_s : decl_s;

-- Syntax 12.3.B
-- generic_association ::=
--     [generic_formal_parameter =>] generic_actual_parameter
-- generic_formal_parameter ::= parameter_simple_name | operator_symbol

-- Syntax 12.3.C
-- generic_actual_parameter ::= expression | variable_name
--     | subprogram_name | entry_name | type_mark

-- 13. Representation Clauses and
-- =====
-- Implementation Dependent Features
-- =====
-- 13.1 Representation Clauses

-- Syntax 13.1
-- representation_clause ::=
--     type_representation_clause | address_clause

-- type_representation_clause ::= length_clause
--     | enumeration_representation_clause | record_representation_clause

    REP ::=                NAMED_REP | record_rep;
    REP =>                  as_name : NAME;

    NAMED_REP =>            as_exp : EXP;

-- 13.2 Length Clause
-- 13.3 Enumeration Representation Clauses

-- Syntax 13.2
-- length_clause ::= for attribute use simple_expression;

-- Syntax 13.3
-- enumeration_representation_clause ::=
--     for type_simple_name use aggregate;

    NAMED_REP ::=          length_enum_rep;
    length_enum_rep => ;

-- 13.4 Record Representation Clauses

```

```
-- Syntax 13.4.A
-- record_representation_clause ::=
--   for type_simple name use
--     record [alignment_clause]
--       {component_clause}
--   end record;

-- alignment_clause ::= at mod static_simple_expression;

ALIGNMENT_CLAUSE ::=  alignment | void;

alignment =>          as_pragma_s : pragma_s,
                     as_exp : EXP;

record_rep =>          as_alignment_clause : ALIGNMENT_CLAUSE,
                     as_comp_rep_s : comp_rep_s;

-- Syntax 13.4.B
-- component_clause ::=
--   component_simple_name at static_simple_expression range static_range;

COMP_REP_ELEM ::=      comp_rep | void;
COMP_REP_ELEM ::=      comp_rep_pragma;

comp_rep_s =>          as_list : Seq OF COMP_REP_ELEM;

comp_rep =>            as_name : NAME,
                     as_exp : EXP,
                     as_range : RANGE;

comp_rep_pragma =>     as_pragma : pragma;

-- 13.5 Address Clauses

-- Syntax 13.5
-- address_clause ::= for simple_name use at simple_expression;

NAMED_REP ::=          address;
address => ;

-- 13.8 Machine Code Insertions

-- Syntax 13.8
-- code_statement ::= type_mark'record_aggregate;

code => ;
```

-- 14.0 Input-Output

-- =====

-- I/O procedure calls are not specially handled. They are
-- represented by procedure or function calls (see 6.4).

-- Predefined Diana Environment

-- =====

```

PREDEF_NAME ::=      attribute_id
                      | pragma_id
                      | argument_id
                      | bltn_operator_id
                      | void;

attribute_id => ;

TYPE_SPEC ::=        universal_integer | universal_fixed | universal_real;

universal_integer => ;
universal_fixed => ;
universal_real => ;

argument_id => ;

bltn_operator_id =>   sm_operator : operator;

pragma_id =>          sm_argument_id_s : argument_id_s;

argument_id_s =>      as_list : Seq Of argument_id;

ALL_SOURCE ::=        DEF_NAME | ALL_DECL | TYPE_DEF | SEQUENCES
                      | STM_ELEM | GENERAL_ASSOC | CONSTRAINT | CHOICE
                      | HEADER | UNIT_DESC | TEST_CLAUSE_ELEM
                      | MEMBERSHIP_OP | SHORT_CIRCUIT_OP | ITERATION
                      | ALTERNATIVE_ELEM | COMP_REP_ELEM | CONTEXT_ELEM
                      | VARIANT_ELEM | ALIGNMENT_CLAUSE | VARIANT_PART
                      | comp_list | compilation | compilation_unit | index;

SEQUENCES ::=         alternative_s | argument_id_s | choice_s
                      | comp_rep_s | compiltn_unit_s | context_elem_s
                      | decl_s | dscrmt_decl_s | general_assoc_s
                      | discrete_range_s | enum_literal_s | exp_s | item_s
                      | index_s | name_s | param_s | pragma_s | scalar_s
                      | source_name_s | stm_s | test_clause_elem_s
                      | use_pragma_s | variant_s;

ALL_SOURCE =>          lx_srcpos : source_position,
                      lx_comments : comments;

ALL_DECL ::=          ITEM | subunit;

```

End

CHAPTER 3
SEMANTIC SPECIFICATION

This chapter describes the semantics of DIANA. The structure of this chapter parallels the DIANA class hierarchy. Each section corresponds to a class in the DIANA class hierarchy, and each subsection corresponds to a subclass of that class in the hierarchy. Each node is discussed in the section corresponding to the class which directly contains it.

Since the class structure of DIANA is a hierarchy, it was possible to construct hierarchy diagrams to illustrate pictorially the relationships between the various nodes and classes. At the end of each major section is a hierarchy diagram which depicts the nodes and classes discussed in that section, along with the attributes which are defined for those nodes and classes. Beneath each class or node name is a list of attribute names corresponding to the attributes which are defined at that level. Hence an attribute appearing immediately below a class name is defined for all classes and nodes which are below that class in the diagram.

It should be noted that the classes `ALL_SOURCE` and `SEQUENCES` have been omitted from this chapter due to the simple nature of their structure and the fact that they represent optional features of DIANA. All nodes which may represent source text have the attributes `lx srcpos` and `lx comments`; however, DIANA does not require that these attributes be represented in a DIANA structure. The sole purpose of class `ALL_SOURCE` is to define these two attributes for its constituents; the only nodes which do not inherit these attributes are those belonging to class `TYPE_SPEC`. In order to be consistent, the IDL specification of DIANA defines a sequence node (or header) for each sequence; however, an implementation is not required to represent the sequence node itself. Class `SEQUENCES` is a set of sequence nodes, all of which have a single attribute (other than `lx srcpos` and `lx comments`) called `as list` which denotes the actual sequence.

The following conventions are observed throughout this chapter:

- (a) All attributes which are inherited by the node `void` are undefined. In addition, no operations are defined for the attributes inherited by the node `void`.
- (b) Although a class may contain the node `void`, an attribute which has that class as its type cannot be `void` unless the semantic specification explicitly states that the attribute may be `void`.
- (c) The attributes `lx srcpos` and `lx comments` are undefined for any nodes which do not represent source code. For certain nodes, such as those in class `PREDEF_NAME`, these attributes will never be defined.
- (d) Unless otherwise specified, all nodes represent source code.
- (e) A sequence cannot be empty unless the semantic specification explicitly allows it.
- (f) If the manual specifies that the copying of a node is optional, and an implementation chooses to copy that node, then the copying of any nodes denoted by structural attributes of the copied node is also optional.

Section 3.1

ALL_DECL

3.1 ALL_DECL

The four immediate offspring of class ALL_DECL are void, subunit, block_master, and ITEM.

The subunit node represents a subunit, and has two non-lexical attributes -- as_name and as_subunit_body. The attribute as_name denotes the name of the parent unit (a selected, used_name_id, or used_op node); as_subunit_body designates the node corresponding to the proper body.

The block_master node represents a block statement that may be a master because it contains immediately within its declarative part the definition of an access type which designates a task. Its only non-lexical attribute, sm_stm, denotes a block_body node. The block_master node can only be referenced by the sm_master attribute of the access node, thereby serving as an intermediate node between the access type definition and the block statement. The block_master node does not represent source code.

3.1.1 ITEM

In general, the nodes in class ITEM correspond to explicit declarations; i.e. declarative items that can be found in formal parts, declarative parts, component lists, and program unit specifications. Certain declarative nodes (subtype_decl, constant_decl, renames_obj_decl, and subprog_entry_decl) may also appear in another context -- as a part of a sequence of declarations constructed for the instantiation of a generic unit. When used in this special context these declarative nodes are not accessible through structural attributes, and do not correspond to source code.

Certain implicit declarations described in the Ada manual are not represented in DIANA: the predefined operations associated with type definitions; label, loop, and block names; anonymous base types created by a constrained array or scalar type definition; anonymous task types; derived subprograms. Although the entities themselves have explicit representations (i.e. defining occurrences), their declarations do not.

With the exception of the node null_comp_decl and the nodes in classes REP and USE_PRAGMA, all of the nodes in class ITEM have a child representing the identifier(s) or symbol(s) used to name the newly defined entity (or entities). These nodes, members of class SOURCE_NAME, are termed the "defining occurrence" of their respective identifiers; they carry all of the information that

describes the associated entity.

The classes DSCRMT_PARAM_DECL, SUBUNIT_BODY, and DECL comprise ITEM.

3.1.1.1 DSCRMT_PARAM_DECL

The DSCRMT_PARAM_DECL class is composed of nodes representing either a discriminant specification or a formal parameter specification. The as name attribute defined on this class denotes a selected or used_name_id node corresponding to the type mark given in the specification.

The dscrmt_dec node represents a discriminant specification. The as source name s attribute denotes a sequence of dscrmt_id nodes, and the as exp attribute references a node corresponding to the default initial value; if there is no initial value given, as exp is void.

3.1.1.1.1 PARAM

A node in class PARAM may represent either a formal parameter specification contained in a formal part, or a generic formal object declaration. The as source name s attribute denotes a sequence of in_id, in_out_id, and out_id nodes, unless the PARAM node corresponds to a generic formal object declaration, in which case only in_id and in_out_id nodes are permitted.

The in node represents a formal parameter declaration of mode in. Its as exp attribute denotes the default value of the parameter, and is void if none is given. The in node also has an lx default attribute which indicates whether or not the mode is specified explicitly.

The in_out and out nodes represent formal parameter declarations of mode in and out, respectively. The as exp attribute of these nodes is always void.

3.1.1.2 SUBUNIT_BODY

The class SUBUNIT_BODY is composed of nodes representing declarations of subunit bodies. The as body attribute defined on this class may denote either a block_body or a stub node, depending on whether the declaration corresponds to a proper body or a body stub.

The subprogram_body node represents the declaration of a subprogram body. The as source name attribute denotes a node in class SUBPROG_NAME, and the as header attribute references a procedure_spec or a function_spec node.

The package_body node represents the declaration of a package body; its as source name attribute refers to a package_id node. If the package body is empty (i.e. it contains no declarative part, no sequence of statements, and no exception handlers) then as body still denotes a block_body node; however, all of the sequences in the block_body node are empty.

The task_body node represents the declaration of a task body; its as_source_name attribute denotes a task_body_id.

3.1.1.3 DECL

The class DECL contains the nodes associated with basic declarative items, record component declarations, and entry declarations.

The node null_comp_decl represents a record component list defined by the word "null". It has no attributes other than lexical ones, and appears only as the first member of a sequence denoted by the as_decl_s attribute of a comp_list node; the only kind of node which can succeed it in the sequence is a pragma node.

3.1.1.3.1 USE_PRAGMA

The class USE_PRAGMA contains the nodes pragma and use.

The pragma node represents a pragma. The as_used_name_id attribute denotes the name of the pragma, and the as_general_assoc_s attribute references a possibly empty sequence of argument associations (the sequence may contain a mixture of assoc and EXP nodes).

The use node represents a use clause. The as_name_s attribute represents the list of package names given in the use clause. If the use clause appears as a basic declarative item, the sequence can contain both used_name_id and selected nodes; if it is a part of a context clause, it will contain used_name_id nodes only.

3.1.1.3.2 REP

The nodes in class REP correspond to representation clauses which may appear as declarative items (i.e. address clauses, length clauses, record representation clauses, and enumeration representation clauses).

The node record_rep represents a record representation clause. The attribute as_name references a used_name_id corresponding to the record type name; as_alignment clause and as_comp_rep_s denote the alignment clause and component clauses, respectively. The attribute as_alignment clause is void if the representation clause does not contain an alignment clause, and as_comp_rep_s may be empty if no component clauses or pragmas are present.

3.1.1.3.2.1 NAMED_REP

The nodes length_enum_rep and address comprise the class NAMED_REP, a group of representation clauses which consist of a name and an expression.

The length_enum_rep node may represent either a length clause or an enumeration representation clause. In the former case the as_name attribute denotes an attribute node and the as_exp attribute corresponds to the simple expression. In the case of an enumeration representation clause the as_name attribute denotes a used_name_id corresponding to the enumeration type, and as_exp references an aggregate node.

The address node represents an address clause. Its as_name attribute references a node from the class USED_SOURCE_NAME corresponding to the name of the entity for which the address is being specified. The as_exp attribute records the address expression.

3.1.1.3.3 ID_DECL

The ID_DECL class represents those declarations which define a single entity rather than a sequence of entities (i.e. declarations defining an identifier, not an identifier list). Included in this class are the type_decl, subtype_decl, and task_decl nodes, as well as the UNIT_DECL and SIMPLE_RENAME_DECL classes, representing unit declarations and renaming declarations, respectively.

The type_decl node represents a type declaration -- incomplete, private, generic, derived, or full. The only type declaration that is not represented by this node is that of a task type, which is denoted by a task_decl node instead. The type_decl node has three non-lexical attributes: as_source_name, as_discrmt_decls, and as_type_def.

The as_source_name attribute of a type_decl node denotes a node representing a new defining occurrence of the type name, the kind of node depending on the kind of type declaration. Certain type names will have more than one declaration point -- those corresponding to incomplete types or (limited) private types. The as_source_name attribute of the type_decl node associated with a (limited) private type declaration references a private_type_id or l_private_type_id node; for all other type declarations as_source_name will designate a type_id node. The subsequent full type declaration for an incomplete or (limited) private type is treated as an ordinary full type declaration; hence the as_source_name attribute of the full type declaration corresponding to a (limited) private type will denote a type_id rather than a private_type_id or l_private_type_id.

The as_discrmt_decls attribute of a type_decl node is a possibly empty sequence containing the discriminant declarations which appear in the type declaration; for declarations of derived types and generic formal types which are not private this sequence is always empty.

The as_type_def attribute associated with a type_decl node designates a node representing the portion of source code following the reserved word "is"; hence the as_type_def attribute for an incomplete type definition is void, and may not be void for any other kind of type declaration. The permitted values of the as_type_def attribute for the remainder of the type declarations are as follows: for a (limited) private type declaration -- a private_def or l_private_def node; for a generic type declaration -- a TYPE_DEF node having the

prefix "formal ", an unconstrained_array_def node, a constrained_array_def node, or an access_def node; for a derived type declaration -- a derived_node; and finally, for a full type declaration -- an enumeration_def, integer_def, float_def, fixed_def, unconstrained_array_def, constrained_array_def, record_def, or access_def node.

The subtype_decl node represents a subtype declaration; it defines two attributes: as source name and as subtype indication. The former denotes a subtype_id node, and the latter a subtype_indication node. The subtype_id represents the defining occurrence of the subtype name, and the subtype_indication node records the type mark and constraint appearing in the subtype declaration.

The second context in which a subtype_decl node may appear is as a part of a normalized parameter list for a generic instantiation, in which case the subtype_decl node does not represent actual source code. This case is discussed in more detail in section 3.6.1.1.

The task_decl node represents the declaration of either a task type or a single task object with an anonymous type, depending on whether or not the reserved word "type" is included in the specification. The difference is indicated by the value of the as source name attribute -- a type_id node in the former case, a variable_id node in the latter. The as_decl_s attribute is a possibly empty sequence of nodes representing the entry declarations and representation clauses given in the task specification (subprog_entry_decl and REP nodes). The declaration of a task object (or objects) of a named type is represented by a variable_decl node rather than a task_decl node.

3.1.1.3.3.1 SIMPLE_RENAME_DECL

The class SIMPLE_RENAME_DECL contains nodes representing the renaming of an object or an exception. The renaming of an entity as a subprogram or a package is represented by a subprog_entry_decl node or a package_decl node, respectively.

A renaming declaration for an object is represented by a renames_obj_decl node. The as source name attribute denotes a variable_id or a constant_id, depending on the kind of object renamed. A constant object is represented by a constant_id; constant objects include constants, discriminants, parameters of mode in, loop parameters, and components of constant objects. An object that does not belong to any of the previous categories is represented by a variable_id (this includes objects of a limited type). The as name attribute of a renames_obj_decl node denotes a node of type NAME which represents the object being renamed. The as type mark name attribute references a selected or used_name_id node corresponding to the type mark appearing in the renaming declaration.

The renames_obj_decl node may also appear in a normalized parameter list for a generic instantiation. This case does not correspond to source code, and is discussed in detail in section 3.6.1.1.

The renaming of an exception is represented by a renames_exc_decl node, for which the as source name attribute always designates an exception_id. The as name attribute can be either a selected node or a used_name_id node corresponding to the exception being renamed.

3.1.1.3.3.2 UNIT_DECL

The class UNIT_DECL represents the declaration of a subprogram, package, generic unit, or entry. The as header attribute which is defined on the class references a HEADER node, the type of which is determined by the reserved word appearing in the declaration (i.e. "procedure", "function", "package", or "entry").

The generic_decl node corresponds to the declaration of a generic unit. The as source name attribute references a generic_id representing the name of the generic unit. The as header attribute may denote a procedure_spec, a function_spec, or a package_spec. The attribute as items is a possibly empty sequence of generic formal parameter declarations -- a list of nodes of type in, in_out, type_decl, or subprog_entry_decl.

3.1.1.3.3.2.1 NON_GENERIC_DECL

The class NON_GENERIC_DECL encompasses subprogram, package, and entry declarations. The as unit kind attribute that is defined on the class determines the kind of declaration the subprog_entry_decl or package_decl node represents: a renaming declaration, an instantiation, a generic formal parameter declaration, or an "ordinary" declaration.

An entry (family) declaration is represented by a subprog_entry_decl node for which the as source name attribute is an entry_id, the as header attribute is an entry node, and the as unit kind attribute is void. The renaming of an entry as a procedure is treated as a procedure declaration (i.e. the as source name attribute is a procedure_id, not an entry_id).

The as source name attribute of a package_decl node will always designate a package_id, and the sm header attribute -- a package_spec. However, the as unit kind attribute may have one of three values: renames unit (representing the name of the unit being renamed), instantiation (representing the name of the generic unit and the generic actual part), or void (if the declaration is an "ordinary" one).

The declaration of a procedure, a function, or an operator is represented by a subprog_entry_decl node, for which the as header attribute can be either a procedure_spec or a function_spec. In addition to the three values of as unit kind described in the previous paragraph, the as unit kind attribute of a subprog_entry_decl node may designate a node from class GENERIC_PARAM if the subprogram in the declaration is a generic formal parameter.

The as source name attribute for a subprogram declaration is a node from class SUBPROG_NAME, with one exception. A declaration renaming an enumeration literal as a function will have an ENUM_LITERAL node as its as source name attribute (the function_spec node denoted by the as header attribute will contain an empty parameter list). For all other declarations the type of node designated by the as source name attribute is determined by the kind of declaration introducing the new name (i.e. a declaration renaming an attribute as a function will have a function_id as its as source name attribute).

A subprog_entry_decl node may also appear in a normalized parameter list for a generic instantiation. In this case the declaration will always be a renaming declaration which does not correspond to source code (see section 3.6.1.1 for details).

3.1.1.3.4 ID_S_DECL

The ID_S_DECL class contains nodes corresponding to declarations which may define more than one entity -- variable declarations, (deferred) constant declarations, record component declarations, number declarations, and exception declarations. Although any of these declarations may introduce a single identifier, a node from class ID_S_DECL will always be used to represent the declaration, never a node from class ID_DECL.

An exception_decl node represents an exception declaration; the as source name s attribute designates a sequence of exception_id nodes.

A deferred_constant_decl node denotes a deferred constant declaration. The as source name s attribute refers to a sequence of constant_id nodes; each constant_id node represents the first defining occurrence of the associated identifier. The as name attribute of the deferred_constant_decl node is a used_name_id or selected node representing the type mark given in the declaration. The subsequent full declaration of the deferred constant(s) will be represented by a constant_decl node.

3.1.1.3.4.1 EXP_DECL

The EXP_DECL class represents multiple object declarations that can include an initial value -- number declarations, variable declarations, and constant declarations.

A number declaration is denoted by a number_decl node for which the as source name s attribute is a sequence of number_id nodes, and the as exp attribute references a node corresponding to the static expression given in the declaration.

3.1.1.3.4.1.1 OBJECT_DECL

Class OBJECT_DECL represents variable, constant, and component declarations.

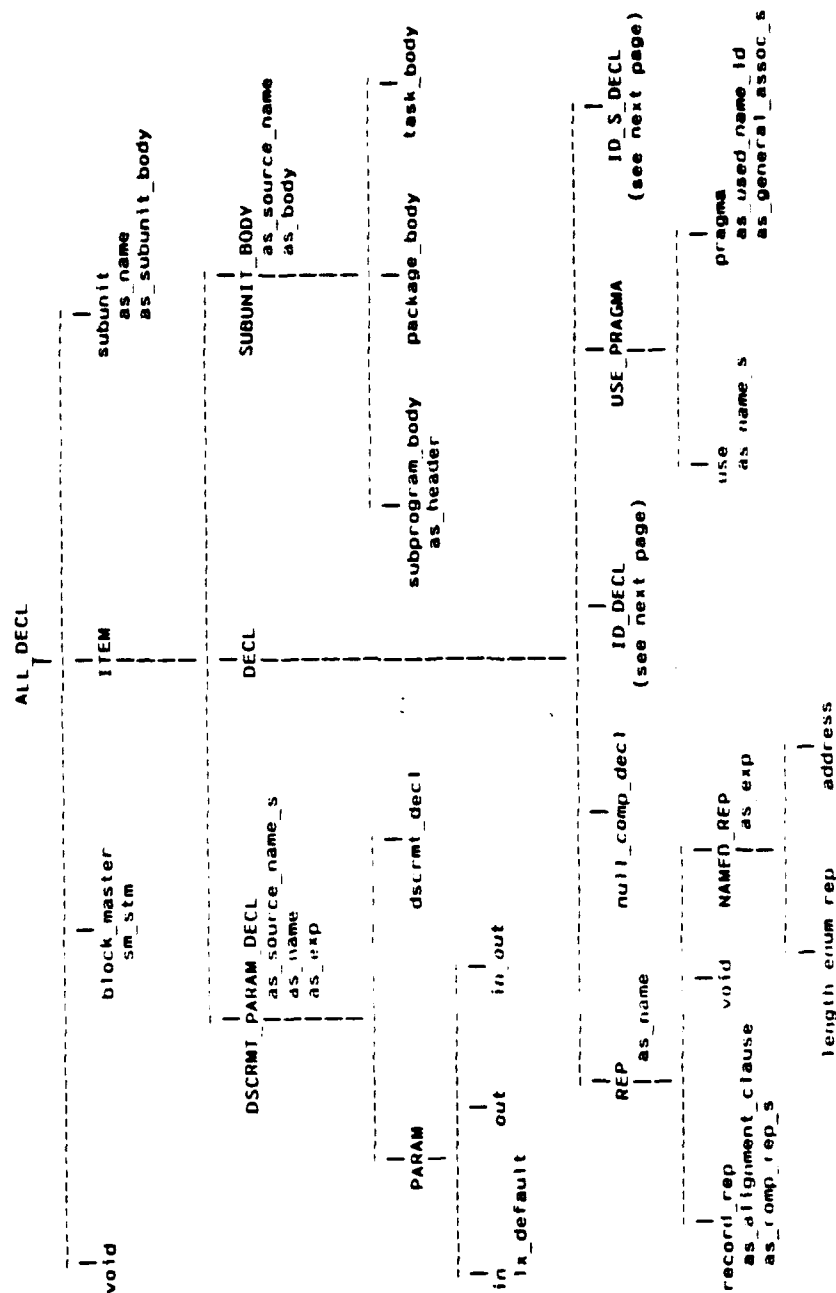
A variable_decl node represents either a variable declaration in a declarative part or a component declaration in a record type definition; as_source_name_s is a sequence of variable_id nodes or component_id nodes, respectively. The as_exp attribute denotes the (default) initial value, and is void if none is given. For a variable declaration, as_type_def may denote either a subtype_indication node or a constrained_array_def node; for a component declaration as_type_def refers to a subtype_indication node.

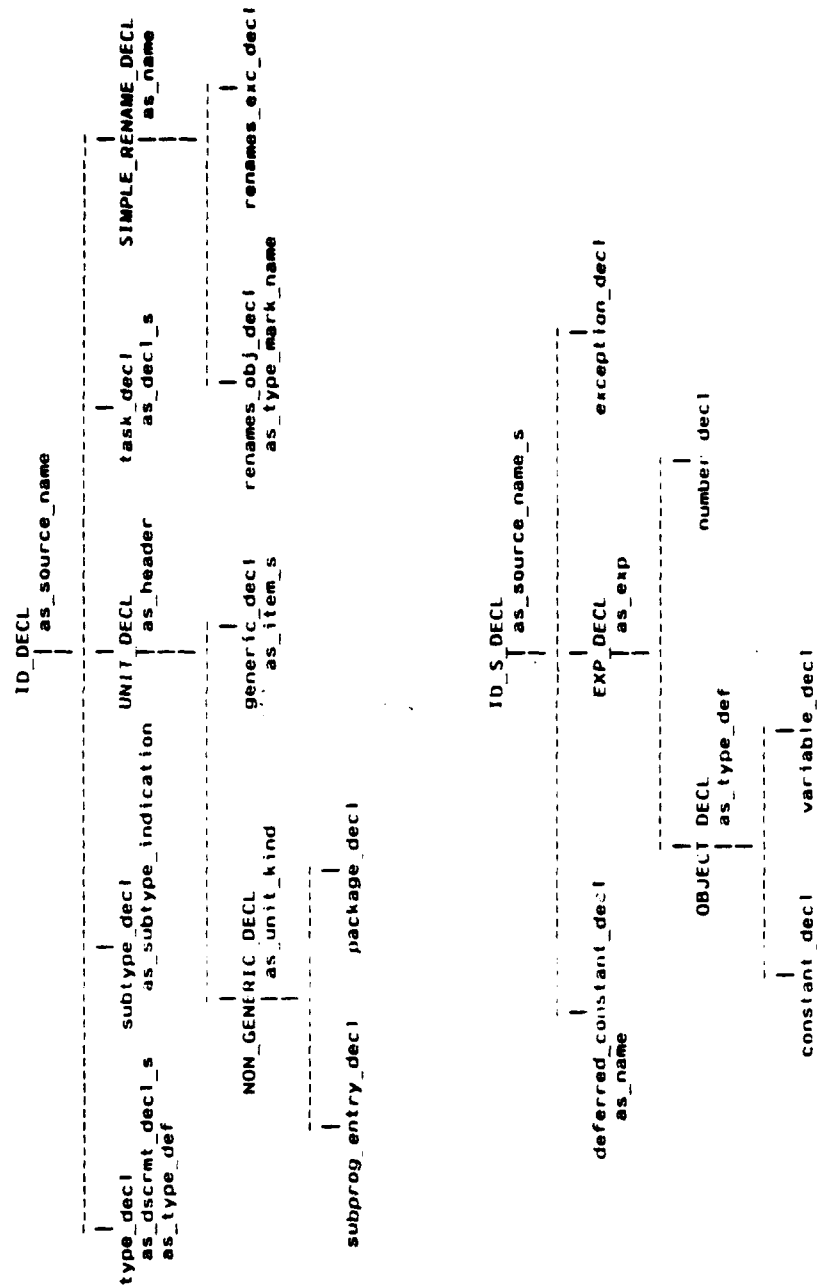
A constant_decl node represents a full constant declaration. The attribute as_source_name_s is a sequence of constant_id nodes; as_exp represents the initial value. The as_type_def attribute may denote either a subtype_indication node or a constrained_array_def node.

A constant_decl node may also appear in a special normalized parameter sequence for a generic instantiation, in which case it does not represent source code (see section 3.6.1.1 for details).

Unlike other object declarations, which contain named types only, the declarations in class OBJECT_DECL may introduce anonymous subtypes via a constrained array definition or the inclusion of a constraint in the subtype indication. If the object(s) being declared are of a named type, then the sm_obj_type attribute of each defining occurrence node in the as_source_name_s sequence denotes the same entity -- the TYPE_SPEC node referenced in the defining occurrence node corresponding to the type mark.

If the object declaration contains an anonymous subtype (i.e. as_type_def denotes a constrained_array_def node or a subtype_indication node with a non-void as_constraint attribute) then a different TYPE_SPEC node will be created for the sm_obj_type attribute of each defining occurrence node in the as_source_name_s sequence. The sm_is_anonymous attribute of each will have the value TRUE. If the constraint is non-static, then each TYPE_SPEC node references its own copy of the CONSTRAINT node corresponding to the new constraint; if the constraint is static then each TYPE_SPEC may or may not reference its own copy. DIANA does not require that the node referenced by the TYPE_DEF attribute of the OBJECT_DECL node have a unique node representing the constraint, even if the constraint is non-static; the OBJECT_DECL node is allowed to share the CONSTRAINT node with one of the TYPE_SPEC nodes.





Section 3.2

DEF_NAME

3.2 DEF_NAME

The appearances of identifiers, operators, and enumeration characters in a DIANA tree are divided into defining and used occurrences; the class DEF_NAME contains all of the nodes representing defining occurrences. Each entity of an Ada program has a defining occurrence; uses of the name or symbol denoting the entity always refer to this definition. The defining occurrence contains the semantic information pertaining to the associated entity; none of the nodes in class DEF_NAME have any structural attributes.

The names represented by this class fall into two principal categories: predefined names and user-defined names. Defining occurrences corresponding to user-defined entities are introduced by the as source name or as source name s attribute of nodes in class ITEM, BLOCK_LOOP, LABELED, and FOR_REV. Defining occurrences associated with predefined entities are not accessible via structural attributes since they do not have a declaration point.

Each node in class DEF_NAME has an lx symrep attribute to retain the source representation of the identifier or character literal associated with the defining occurrence. Those nodes in class SOURCE_NAME generally have lx srcpos and lx comments attributes for which the values are defined; the values of these attributes are undefined for nodes in class PREDEF_NAME. Certain nodes in class SOURCE_NAME may be used to represent both predefined and user-defined names (nodes such as exception_id); however, lx srcpos and lx comments for these nodes are undefined when representing a predefined name.

The names associated with certain entities may have more than one point of definition; in particular, those corresponding to:

- (a) deferred constants
- (b) incomplete types
- (c) non-generic (limited) private types
- (d) discriminants
- (e) non-generic formal parameters
- (f) program units

For these names, the first defining occurrence (which is indicated by the sm first attribute) is treated as THE definition. In general, all references to the entity refer to the first defining occurrence, and the multiple defining occurrences of an entity all have the same attribute values. Types and deferred constants present special cases which are discussed in subsequent sections.

3.2.1 PREDEF_NAME

The nodes in class PREDEF_NAME correspond to the names of entities for which the Ada language does not provide a means of declaration; consequently a node from class PREDEF_NAME will NEVER be designated by a structural attribute.

The nodes attribute_id, argument_id, pragma_id, bltn_operator_id, and void comprise this class. The nodes argument_id (the name of a pragma argument or argument value) and attribute_id (the name of an Ada attribute) have no attributes other than lx symrep. The pragma_id represents the name of a pragma. The sm argument id s attribute denotes a sequence of argument identifiers associated with the pragma (i.e. the sequence for pragma LIST contains nodes denoting the argument identifiers ON and OFF); if a particular pragma has no argument identifiers the sequence is empty. The node bltn operator id corresponds to a predefined operator; the different operators are distinguished by the sm operator attribute.

3.2.2 SOURCE_NAME

The SOURCE_NAME class is composed of those nodes corresponding to defining occurrences of entities which may be declared by the user.

The exception_id node represents an exception name. If the exception_id is a renaming then the sm renames attribute is a used_name_id or a selected node denoting the original exception name (the node which is designated by the as name attribute of the renames_exc_decl node). If the exception name is not introduced by a renaming declaration then sm renames is void.

An entry (family) name is denoted by an entry_id node which has two non-lexical attributes : sm spec and sm address. The sm spec attribute references the entry node (which contains the discrete range and formal part) designated by the as header attribute of the subprog_entry_decl node. The sm address attribute denotes the expression given in an address clause; if no address clause is applicable this attribute is void.

3.2.2.1 LABEL_NAME

The class LABEL_NAME represents those identifiers associated with statements; the sm stm attribute defined on this class denotes the statement to which the name corresponds. A label_id node represents the name of a statement label and is introduced by a labeled node; sm stm can reference any node in class STM. A block_loop_id represents the name of a block or a loop; sm stm

denotes the block or loop node which introduces the block_loop_id.

3.2.2.2 TYPE_NAME

The class TYPE_NAME contains nodes associated with the names of types or subtypes; it has an sm_type_spec attribute defined on it. Certain type names may have more than one defining occurrence; in particular, those corresponding to private and limited private types which are not generic formal types, and those associated with incomplete types.

A private_type_id or l_private_type_id node represents the defining occurrence of a type name introduced by a (limited) private type declaration; the type may or may not be a generic formal type. A private_type_id or l_private_type_id node has an sm_first attribute that references itself, and an sm_type_spec attribute denoting a private or l_private node.

If the (limited) private type is not a generic formal type then its name has a second defining occurrence corresponding to the subsequent full type declaration. The second defining occurrence is represented by a type_id node; the sm_first attribute references the private_type_id or l_private_type_id node of the corresponding (limited) private type declaration, and the sm_type_spec attribute denotes the full type specification, a node belonging to class FULL_TYPE_SPEC.

Used occurrences of a (limited) private type name will reference the private_type_id or l_private_type_id as the definition.

Each defining occurrence of the name of an incomplete type is represented by a type_id node, the sm_first attribute of which denotes the type_id node corresponding to the incomplete type declaration. Ordinarily, the sm_type_spec attribute of the type_id nodes for both the incomplete and the full type declaration refer to the full type specification -- a node from class FULL_TYPE_SPEC. The single exception occurs when the incomplete type is declared "immediately within the private part of a package" [ARM, section 3.8.1] and the package body containing the full type declaration is a separate compilation unit, in which case the sm_type_spec attribute of the type_id corresponding to the incomplete type declaration denotes an incomplete node.

The defining occurrences of all other kinds of type names are represented by type_id nodes. The sm_first attribute references the node which contains it, and the sm_type_spec attribute denotes a node belonging to the class FULL_TYPE_SPEC.

A new TYPE_SPEC node is created for the sm_type_spec attribute of a type_id node unless the type_id corresponds to an incomplete type declaration and the full type declaration is in the same compilation unit. A new private or l_private node is always created for the sm_type_spec attribute of a private_type_id or l_private_type_id node.

A subtype_id node represents the defining occurrence of a subtype name; its only non-lexical attribute is sm_type_spec, which references the appropriate subtype specification. If the subtype_id is introduced by a subtype declaration

in which the subtype indication contains a constraint then a new TYPE_SPEC node is created to represent the subtype specification. If the subtype declaration does not impose a new constraint then the sm type spec attribute references the TYPE_SPEC node associated with the type mark appearing in the declaration.

A subtype id may also be introduced by a declarative node in a normalized parameter list for a generic instantiation, in which case the subtype id does not correspond to source code. The correct values for its attributes in this instance are defined in section 3.6.1.1.

3.2.2.3 OBJECT_NAME

The class OBJECT_NAME contains nodes representing defining occurrences of entities having a value and a type; it is composed of iteration id, ENUM_LITERAL, and INIT OBJECT_NAME. The sm obj type attribute which is defined on the class denotes the subtype of the object or literal.

An iteration id represents the defining occurrence of a loop parameter, and is introduced by an iteration node. The sm obj type attribute references the enumeration or integer node denoted by the sm base type attribute of the DISCRETE_RANGE node associated with the iteration scheme.

3.2.2.3.1 ENUM_LITERAL

The class ENUM_LITERAL is composed of nodes representing the defining occurrences of literals associated with an enumeration type. The nodes enumeration id and character id comprise this class -- enumeration id corresponds to an identifier, character id to a character literal.

ENUM_LITERAL defines the attributes sm pos and sm rep, both of which are of type Integer. The attribute sm pos contains the value of the predefined Ada attribute POS, i.e. the universal integer corresponding to the actual position number of the enumeration literal. The sm rep attribute contains the value of the predefined Ada attribute VAL; the user may set this value with an enumeration representation clause. If no such clause is in effect, the value of sm rep will be the same as that of sm pos. The sm obj type attribute references the enumeration node corresponding to the enumeration type to which the literal belongs.

An ENUM_LITERAL node may be introduced by either an enumeration_def node or a subprog_entry_decl node. The latter corresponds to the renaming of an enumeration literal as a function, in which case the semantic attributes of the ENUM_LITERAL node will have the same values as those of the node corresponding to the original literal.

An ENUM_LITERAL node may be introduced by a declarative node in a special normalized parameter list for a generic instantiation; in this instance the ENUM_LITERAL node does not correspond to source code. This case is discussed in detail in section 3.6.1.1.

3.2.2.3.2 INIT_OBJECT_NAME

The class INIT_OBJECT_NAME contains nodes corresponding to defining occurrences of objects which may have an initial value; it defines an attribute sm init exp to record this value. This attribute represents those (default) initial values which are explicitly given; i.e. the default value NULL for an access object is not represented by sm init exp unless it is explicitly specified in the source code. The objects denoted by the nodes of this class include named numbers, variables, constants, record components, and formal parameters.

The node number_id represents the definition of a named number. The sm obj type attribute denotes a universal integer or universal real node, and the sm init exp attribute references the node denoted by the as exp attribute of the corresponding number_decl node.

3.2.2.3.2.1 VC_NAME

The class VC_NAME is composed of the nodes variable_id and constant_id, denoting the names of variables and constants, respectively. The attributes sm renames obj and sm address are defined for the nodes in this class.

The sm renames obj attribute is of type Boolean, and indicates whether or not the name of the object is a renaming; the value of this attribute determines the meaning of the sm init exp attribute for nodes in this class. If the name is introduced by a renaming declaration then sm init exp denotes the NAME node referenced by the as name attribute of the renames_obj_decl node. Otherwise, sm init exp is the EXP node designated by the as exp attribute of the associated OBJECT_DECL node, and consequently may be void.

The sm address attribute denotes the expression for the address of the object as given in an address clause; if no such clause is applicable sm address is void. In the case of a renaming, the value of the sm address attribute is determined by the original object; if the original object cannot be named in an address clause then sm address is void.

For a VC_NAME node corresponding to an ordinary object declaration the sm obj type attribute denotes either the TYPE_SPEC node corresponding to the type mark in the declaration, or an anonymous TYPE_SPEC node if the declaration contains a constrained array definition or a constraint in the subtype indication. If the variable_id or constant_id is introduced by a renames_obj_decl node, then sm obj type is the TYPE_SPEC node corresponding to the subtype of the original object (hence this TYPE_SPEC node does not necessarily correspond to the type mark in the renaming declaration, although it will have the same base type).

A constant_id represents the name of a constant object. A constant object may be either a (deferred) constant or the renaming of one of the following: a (deferred) constant, a discriminant, a loop parameter, a (generic) formal parameter of mode in, or a component of a constant object. The sm first attribute references the constant_id node corresponding to the first defining occurrence of the associated name. For a constant_id node associated with the

full declaration of a deferred constant this attribute will reference the constant_id corresponding to the deferred declaration; for all other constant_id nodes the sm first attribute will contain a self-reference.

The attributes of the constant_id nodes representing the defining occurrences of a deferred constant have the same values. The sm obj type attribute designates a private or l_private node, and sm init exp denotes the initialization expression given in the full constant declaration. Used occurrences of a deferred constant name reference the constant_id of the deferred declaration.

The variable_id node represents the name of an object which is declared in an object declaration or a renaming declaration but is not a constant object. The sm is shared attribute has a Boolean value indicating whether or not a SHARED pragma has been applied to the variable. If the variable_id represents a renaming then sm is shared indicates whether or not the original object is shared.

Both the constant_id and the variable_id nodes may be introduced by declarative nodes in a normalized parameter list for a generic instantiation, in which case they do not represent source code. The appropriate values for the attributes of each are discussed in section 3.6.1.1.

3.2.2.3.2.2 COMP_NAME

The nodes component_id and discriminant_id comprise the class COMP_NAME, which represents the defining occurrences of identifiers associated with record components and record discriminants. The attribute sm comp rep is defined for the nodes in this class; it references the node corresponding to the applicable component representation clause, and is void if no such clause exists. The attribute sm_comp_rep can never denote a comp_rep_pragma node.

The sm init exp attribute represents the default initial value, referencing the EXP node designated by the as exp attribute of the variable_decl or dscrmt_decl node (hence sm init exp can be void).

Unlike component names, discriminant names may have multiple defining occurrences, therefore an sm first attribute is defined for the discriminant_id node (the instance of a component name in a component representation clause is considered to be a used occurrence rather than a defining occurrence). If an incomplete or non-generic (limited) private declaration contains a discriminant part, the discriminants will have a second definition point at the full type declaration; the sm first attribute of both discriminant_id nodes will reference the discriminant_id node corresponding to the earlier incomplete or (limited) private declaration.

3.2.2.3.2.3 PARAM_NAME

The class PARAM_NAME contains nodes corresponding to the names of formal parameters declared in the formal parts of subprograms, entries, accept

statements, and generic units. The nodes in_id, in_out_id, and out_id comprise PARAM_NAME, representing parameters of mode in, in out, and out, respectively (an out_id node can never be used to represent a generic formal object).

The attribute sm init exp records the initial value; it denotes the EXP node referenced by the as exp attribute of the corresponding in, in out, or out node. The attribute sm init exp is void for in_out_id and out_id nodes.

Formal parameters associated with subprogram declarations, entry declarations, and accept statements may have more than one defining occurrence. The sm first attribute for a PARAM_NAME node belonging to an entry declaration or an accept statement will always reference the PARAM_NAME node of the entry declaration. The sm first attribute of a PARAM_NAME node corresponding to a subprogram name denotes the PARAM_NAME node of the subprogram declaration, body declaration, or stub declaration which first introduces the identifier.

3.2.2.4 UNIT_NAME

The class UNIT_NAME represents the defining occurrences of those identifiers and symbols associated with program units; it contains the nodes task_body_id, generic_id, and package_id, as well as the class SUBPROG_NAME.

The task_body_id node denotes a task unit name introduced by the declaration of a body or a stub. The sm first attribute references the type_id or variable_id node (depending on whether or not the task type is anonymous) of the task specification. The sm type spec attribute denotes the task_spec node denoted by either the sm type spec attribute of the type_id node or the sm obj type attribute of the variable_id node.

If the body of the task is in the same compilation unit then the sm body attribute of the task_body_id references the body (a block body node). If the body is in another compilation unit, but the stub is not, then sm body denotes the stub (a stub node). Otherwise sm body is void.

3.2.2.4.1 NON_TASK_NAME

The nodes in class NON_TASK_NAME correspond to the names of program units which are not tasks. The node generic_id and the class SUBPROG_PACK_NAME comprise this class.

The generic_id node corresponds to the defining occurrence of the name of a generic unit (the name of an instantiated unit is represented by a member of class SUBPROG_PACK_NAME). The sm first attribute of a generic_id always references the generic_id of the generic specification. The sm spec attribute denotes the procedure_spec, function_spec, or package_spec associated with the subprogram or package specification. The attribute sm generic params represents the formal part of the generic specification, and references the same sequence as the as items attribute of the corresponding generic_decl node. The sm is inline attribute indicates whether or not an INLINE pragma has been given for the generic unit. The value of the sm body attribute is determined in the

same manner as the sm body attribute of the task_body_id node (discussed in the previous section).

3.2.2.4.1.1 SUBPROG_PACK_NAME

Defining occurrences of packages and subprograms are represented by members of class SUBPROG_PACK_NAME. The attributes sm address and sm unit desc are defined on this class. The sm address attribute records the expression given in an address clause for the unit, if such a clause does not exist then sm address is void. The sm unit desc attribute is a multi-purpose attribute; in some cases it is used to indicate that a particular unit is a special case (such as a renaming), in others it is used as a "shortcut" to another node (such as the unit body).

The node package_id represents the defining occurrence of a package; its sm spec attribute denotes a package_spec node. If the package_id does not correspond to a renaming or an instantiation then sm spec references the package_spec designated by the as header attribute of the package_decl node, sm first references the package_id of the package specification, and sm unit desc denotes a node from class BODY (the value of this attribute is determined in the same manner as the value of the sm body attribute of the task_body_id, which is discussed in section 3.2.2.4).

If the package_id corresponds to a renaming then the sm unit desc attribute references a renames_unit node which provides access to the original unit. The sm first attribute of the package_id contains a self-reference, while the sm spec and sm address attributes have the same values as those of the original package.

If the package_id is introduced by an instantiation then sm unit desc designates an instantiation node containing the generic actual part as well as a normalized parameter list. The sm first attribute of the package_id contains a self-reference; the value of sm address is determined by the existence of an address clause for the instantiated package, consequently it may be void. The sm spec attribute references a new package_spec node that is created by copying the specification of the generic unit and replacing every occurrence of a formal parameter by a reference to an entity in the normalized parameter list. The construction of the new specification is discussed in further detail in section 3.6.1.1.

3.2.2.4.1.1.1 SUBPROG_NAME

The class SUBPROG_NAME represents defining occurrences of subprograms; it comprises the nodes procedure_id, function_id, and operator_id. The attributes sm is inline and sm interface are defined for the nodes in this class. The sm is inline attribute has a boolean value which indicates whether or not an INLINE pragma has been given for the subprogram. If an INTERFACE pragma is given for the subprogram then sm interface denotes the pragma, otherwise it is void.

The procedure_id node corresponds to a defining occurrence of a procedure or an entry renamed as a procedure; its sm spec attribute references a procedure_spec node. In addition to representing a function, a function_id may represent an attribute or operator renamed as a function. An operator_id may denote an operator or a function renamed as an operator. The sm spec attribute of a function_id or an operator_id designates a function_spec node.

If the SUBPROG_NAME node is introduced by an "ordinary" declaration then sm unit desc denotes a member of class BODY, and sm spec references the HEADER node denoted by the as header attribute of the associated subprog_entry_decl node. The appropriate BODY node is selected in the manner described for the sm body attribute of the task_body_id node in section 3.2.2.4.

Like a package_id, a SUBPROG_NAME node may be introduced by a renaming declaration, in which case sm unit desc denotes a renames_unit node and sm first contains a self-reference. However, the sm spec attribute of the SUBPROG_NAME node does not denote the specification of the original unit, but that of the renaming declaration. The values of the attributes sm address, sm is inline, and sm interface are the same as those of the original unit.

The instantiation of a subprogram is treated in the same manner as the instantiation of a package. The sm unit desc attribute denotes an instantiation node, sm first contains a self-reference, and a new procedure_spec or function_spec is constructed in the manner described in section 3.6.1.1. The values of sm address and sm interface are determined by the presence of an associated address clause or INTERFACE pragma; either may be void. The sm is inline attribute is true if an INLINE pragma is given for the generic unit OR the instantiated unit.

A SUBPROG_NAME node may also represent a generic formal parameter, in which case sm unit desc denotes a node belonging to class GENERIC_PARAM, the sm first attribute contains a self-reference, and sm spec denotes the HEADER node introduced by the generic parameter declaration. The attributes sm address and sm interface are void, and sm is inline is false.

The sm unit desc attribute of an operator_id may reference an implicit_not_eq node, which indicates that the inequality operator has been declared implicitly by the user through the declaration of an equality operator. The inequality operator is not the predefined operator, but because it cannot be explicitly declared it has no corresponding body, hence that of the corresponding equality operator must be utilized. Access to the equality operator is provided by the implicit_not_eq node. An operator_id which contains a reference to an implicit_not_eq node can be denoted only by semantic attributes.

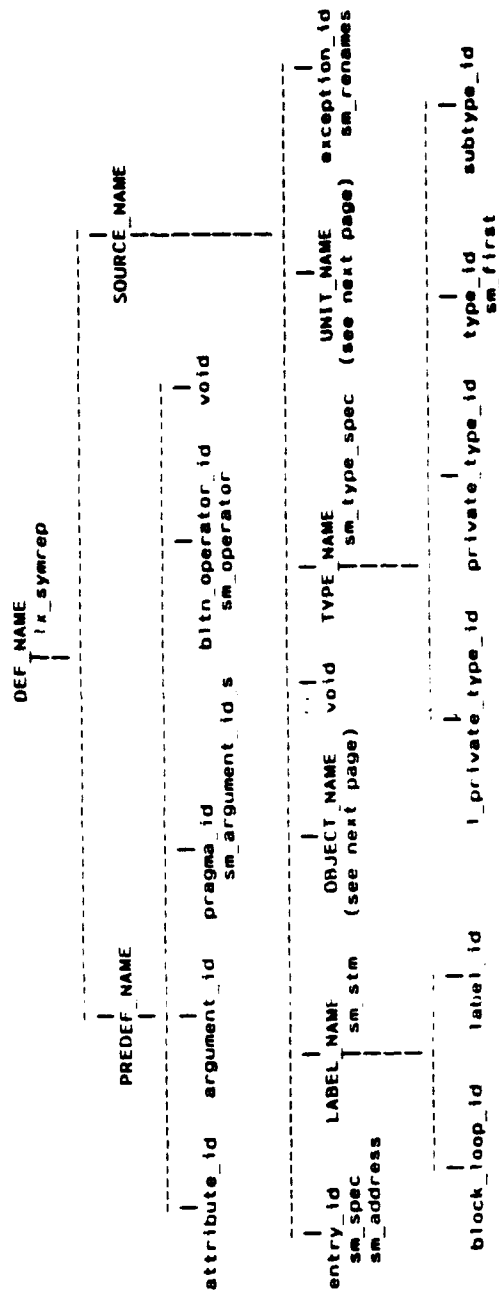
The sm spec attribute of an operator_id representing an implicitly declared inequality operator may reference either the function_spec of the corresponding equality operator or a copy of it. The attribute sm address is void, sm interface has the same value as the sm interface attribute of the corresponding equality operator, and the value of sm is inline is determined by whether or not an INLINE pragma is given for the implicitly declared inequality operator.

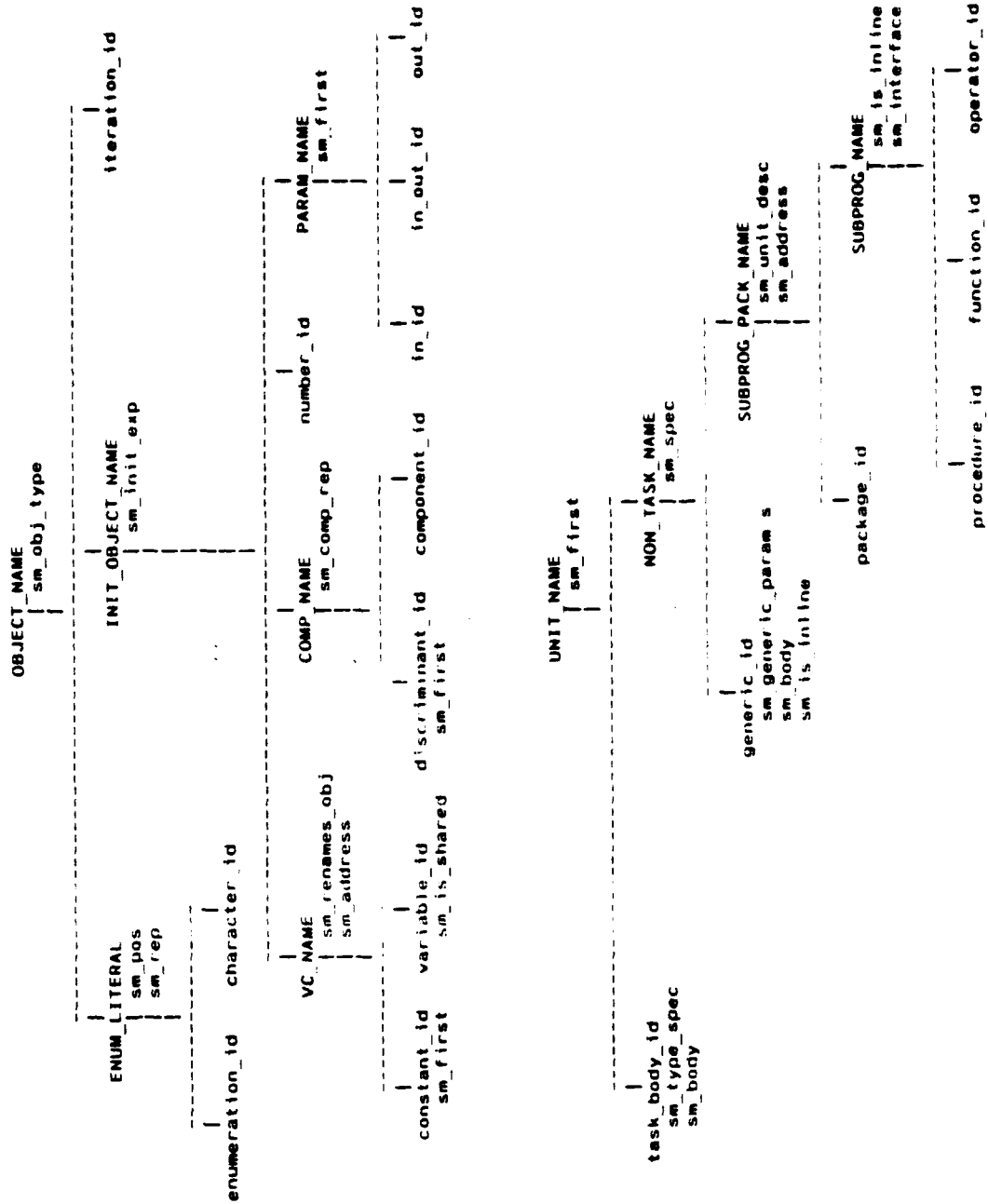
The sm unit desc attribute of a SUBPROG NAME node may reference a derived subprog node, in which case the procedure or function is a derived subprogram. The specification of the derived subprogram is obtained by copying that of the corresponding subprogram of the parent type, and making the following substitutions:

- (a) each reference to the parent type is replaced by a reference to the derived type
- (b) each reference to a subtype of the parent type is replaced by a reference to the derived type
- (c) each expression of the parent type is replaced by a type conversion which has the expression as the operand and the derived type as the target type.

The remaining attributes have the following values: sm address is void, sm interface has the same value as the sm interface attribute of the corresponding derivable subprogram, and the value of sm is inline is determined by the existence of an INLINE pragma for the derived subprogram.

The nodes in class SUBPROG NAME may be introduced by declarative nodes in a normalized parameter list constructed for a generic instantiation, in which case they do not correspond to source code. A more detailed discussion may be found in section 3.6.1.1.





Section 3.3

TYPE_SPEC

3.3 TYPE_SPEC

The classes `TYPE_SPEC` and `TYPE_DEF` are complementary -- the former represents the semantic concept of an Ada type or subtype, the latter represents the syntax of the declaration of an Ada type or subtype. A `TYPE_SPEC` node does not represent source code; it has no lexical or structural attributes, only semantic attributes and code attributes. A `TYPE_DEF` node has no other purpose than to record source code, containing only lexical and structural attributes. A node from class `TYPE_SPEC` will NEVER be designated by a structural attribute, a node from class `TYPE_DEF` node will NEVER be designated by a semantic attribute.

Each distinct type or subtype is represented by a distinct node from class `TYPE_SPEC`; furthermore, there are never two `TYPE_SPEC` nodes for the same entity. Although anonymous type and subtype declarations are not represented in DIANA, the anonymous types and subtypes are themselves represented by nodes from class `TYPE_SPEC`.

The nodes `universal_integer`, `universal_real`, and `universal_float` represent the universal types; they have no attributes.

The `incomplete` node represents a special kind of incomplete type. Ordinarily incomplete types are not represented by `TYPE_SPEC` nodes, all references are to the full type specification. The sole exception occurs when an incomplete type declaration is given in the private part of the package, and the subsequent full type declaration appears in the package body, which is in a separate compilation unit. In this case the incomplete type is represented by an `incomplete` node, and all references denote this node rather than the full type specification. The `incomplete` node defines an `sm discriminant s` attribute which denotes the sequence of discriminant declarations designated by the `as dscrm t decl s` attribute of the `type_decl` node introducing the incomplete type. This sequence may be empty.

3.3.1 DERIVABLE_SPEC

The class `DERIVABLE_SPEC` consists of nodes representing types which may be derived. The attribute `sm derived` which is defined on this class refers to the parent type if the type is `derived`; otherwise it is `void`. The `sm derived` attribute is `void` for a subtype of a derived type. The nodes in this class also have a boolean attribute, `sm is anonymous`, which indicates whether or not the type or subtype has a name.

A derived type is always represented by a new node corresponding to a new base type (the node is the same kind as that of the parent type). If the constraints on the parent type are not identical to those on the parent subtype then the base type is anonymous, and a new node corresponding to a subtype of that type is also created. The node associated with the subtype records the additional constraint (the constraint may be given explicitly in the derived type definition or implicitly by the type mark).

In addition to being created by a derived type definition, a derived type may be introduced by a numeric type definition. The base type of a user-defined numeric type is an anonymous derived type represented by the appropriate **integer**, **float**, or **fixed** node. The sm derived attribute of the node for the anonymous base type refers to the node corresponding to the appropriate predefined type.

If a derived type is an enumeration type then a sequence of new enumeration literals is created for the derived type, unless the parent type is a generic formal type. The value of sm pos in each new **ENUM_LITERAL** node is the same as that in the corresponding node from the parent type; however, the sm obj type attribute denotes the enumeration node for the derived type. The value of sm rep depends on whether or not a representation clause is given for the derived type; if not, the value is taken from the corresponding node from the parent type.

If a derived type is a record type and a representation clause is given for that derived type, then a sequence of new discriminants and a sequence of new record components are created for the derived type. If a representation clause is not given for the derived record type then construction of the new sequences is optional. Excluding sm comp rep, the values of all of the attributes in each new **COMP_NAME** node will be the same as those in the corresponding node from the parent type; sm comp rep will be the same only if no representation clause is given for the derived type.

Certain members of class **DERIVABLE_SPEC** may represent generic formal types. The attributes of these nodes reflect the properties of the generic formal types, not those of the corresponding actual subtypes. For instance, the sm size attribute of an **array** node corresponding to a generic formal array type is always **void**, reflecting the fact that a representation clause cannot be given for a generic type. The value of this attribute implies nothing about the value of this attribute in the **array** node of a corresponding actual subtype. The values of attributes having a uniform value when corresponding to generic formal types are discussed in the appropriate sections.

The sm derived attribute of a **DERIVABLE_SPEC** node representing a generic formal type is always **void**, and sm is anonymous is always **false**.

3.3.1.1 PRIVATE_SPEC

The nodes in class **PRIVATE_SPEC** -- **private** and **l private** -- represent **private** and **limited private** types, respectively. The attributes sm discriminant s and sm type spec are defined for these nodes. The sm discriminant s attribute references the sequence of discriminant declarations

introduced by the (limited) private type declaration; hence it may be empty. The sm type spec attribute designates the full type specification (a node from class FULL_TYPE_SPEC) unless the node corresponds to a generic formal private type, in which case the value of sm type spec is undefined.

A subtype or derived type declaration which imposes a new constraint on a (limited) private type results in the creation of a constrained_record node if the declaration occurs in the visible part or outside of the package; if the declaration occurs in the private part or the package body then a node from class CONSTRAINED or class SCALAR is created. The sm base type attribute of the new node references the private or l_private node associated with the type mark.

An attribute of type TYPE_SPEC that denotes a (limited) private type always references the private or l_private node. Access to the associated full type specification is provided by the sm type spec attribute of the PRIVATE_SPEC node.

3.3.1.2 FULL_TYPE_SPEC

The class FULL_TYPE_SPEC represents types which are fully specified. The node task_spec and the class NON_TASK comprise FULL_TYPE_SPEC.

The task_spec node represents a task type. A task type may be anonymous if the reserved word "type" is omitted from the task specification, in which case the task_spec node will be introduced by the sm obj type attribute of a variable_id rather than the sm type spec attribute of a type_id.

The task_spec node defines five additional semantic attributes: sm decl s, sm body, sm address, sm size, and sm storage size. The sm decl s attribute denotes the sequence of entry declarations and representation clauses designated by the as decl s attribute of the associated task_decl node. The attribute sm body denotes the block_body node corresponding to the task body if it is in the same compilation unit; if not, sm body refers to the stub node if the stub is in the same compilation unit; if neither the body nor the stub is in the same compilation unit, then sm body is void. Each of the remaining semantic attributes (sm address, sm size, and sm storage size) denotes the EXP node of the corresponding representation clause, if one exists; otherwise it is void.

3.3.1.2.1 NON_TASK

Class NON_TASK represents fully specified types which are not tasks. The nodes in this class are used to denote both types and subtypes. The attribute sm base type which is defined on this class references the base type -- a node containing all of the representation information. The sm base type attribute of a NON_TASK node representing a generic formal type always contains a self-reference. The classes SCALAR, UNCONSTRAINED, and CONSTRAINED comprise NON_TASK.

3.3.1.2.1.1 SCALAR

The nodes in class **SCALAR** represent scalar types and subtypes. A scalar subtype is denoted by the same kind of node as the type from which it is constructed (unless it is constructed from a private type); however, a type may always be distinguished from a subtype by the fact that the sm base type attribute of a node corresponding to a type references itself.

The **SCALAR** class has an sm range attribute which references a node corresponding to the applicable range constraint. In most cases this node already exists (the source code has supplied a constraint, or the range from the appropriate predefined type is applicable); however, in certain instances a new range node must be constructed.

A new range node is created for an **enumeration** node introduced by either an enumeration type definition or a derived type definition which does not impose a constraint. The as expl and as exp2 attributes of the range node denote **USED_OBJECT** nodes corresponding to the first and last values of the enumeration type. A new **RANGE** node is also created when more than one object is declared in an object declaration containing an anonymous subtype with a non-static range constraint. The subtypes of the objects do not share the same **RANGE** node in this case; a new copy of the **RANGE** node is made for the new subtype of each additional object in the declaration (if the constraint is static, the copy is optional).

The attribute cd impl size which is defined on this class contains the universal integer value of the Ada attribute **SIZE**; it may be less than a user-defined size.

The nodes in class **SCALAR** may also represent generic formal scalar types. The **enumeration** node represents a formal discrete type; the **integer** node a formal integer type; the **float** node a formal floating point type; and the **fixed** node a formal fixed point type. The sm range attribute for a generic formal scalar type is undefined.

The node **enumeration** represents an enumeration type. If the type is not a generic formal type then the sm literal s attribute references the sequence of enumeration literals -- either the sequence denoted by the as enum literal s attribute of the **enumeration_def** node or a new sequence of literals created for a derived type. If the **enumeration** node represents a generic formal type then sm literal s denotes an empty sequence.

The **integer** node represents an integer type; it defines no attributes of its own.

3.3.1.2.1.1.1 REAL

The nodes in class **REAL** -- **float** and **fixed** -- represent floating point types and fixed point types, respectively. If the type is not a generic formal type the sm accuracy attribute contains the value of the accuracy definition: digits for the **float** node, and delta for the **fixed** node. The value of sm accuracy for a generic formal type is undefined. The **fixed** node defines an

additional attribute, cd impl small, which has the value of the Ada attribute SMALL.

3.3.1.2.1.2 UNCONSTRAINED

An unconstrained array, record, or access type is represented by a node from class UNCONSTRAINED. The sm base type attribute of an array, record, or access node always contains a self-reference. The sm size attribute which is defined for this class references the EXP node given in a length clause for that type; if no such clause is given then sm size is void.

The access node represents an unconstrained access type. An access type is unconstrained if its designated type is an unconstrained array type, an unconstrained record type, a discriminated private type, or an access type having a designated type which is one of the above; otherwise, it is constrained. A derived access type is unconstrained if its parent subtype is unconstrained and the derived type definition does not contain an explicit constraint.

The sm desig type attribute denotes the TYPE_SPEC node corresponding to the designated type -- an incomplete node, or a node from class UNCONSTRAINED or class PRIVATE_SPEC (if sm desig type denotes an access node, then the sm desig type attribute of that access node cannot refer to another access node). The TYPE_SPEC node referenced by the sm desig type attribute of an access node is never anonymous.

The access node also defines the attributes sm storage size, sm is controlled, and sm master. The sm storage size attribute denotes the EXP node given in a length clause if one is applicable, otherwise it is void. The attribute sm is controlled is of type Boolean, and indicates whether or not a CONTROLLED pragma is in effect for that type.

The attribute sm master is defined only for those access types having a task as a designated subtype. In those cases it references the master which contains the corresponding access type definition. If the master is a program unit then sm master denotes the declaration of the unit -- a task_decl, subprog_entry_decl, or package_decl node. If the master is a block then sm master denotes a block_master node, which contains a reference to the block statement containing the access type definition.

The array and access nodes may represent generic formal types, in which case the sm size attribute is void, sm storage size is void, sm is controlled is false, and sm is packed is false.

3.3.1.2.1.2.1 UNCONSTRAINED_COMPOSITE

The class UNCONSTRAINED_COMPOSITE represents unconstrained composite types; it is composed of the nodes array and record. Two Boolean attributes are defined on this class: sm is limited and sm is packed. The attribute sm is limited indicates whether or not the type has any subcomponents which are

of a limited type; sm is packed records the presence or absence of a PACK pragma for that type.

The array node defines two attributes of its own: sm index s and sm comp type. The sm index s sequence represents the index subtypes (undefined ranges) of the array. The attribute sm comp type references a TYPE_SPEC node corresponding to the component subtype; if the subtype indication representing the component subtype imposes a new constraint then this TYPE_SPEC node is an anonymous subtype.

The node record defines the attributes sm discriminant s, sm comp list, and sm representation. The sm discriminant s attribute denotes the sequence of discriminant declarations referenced by the as dscrm t decl s attribute of the type decl node introducing the record type; this sequence may be empty. The sm comp list attribute represents the component list, and the attribute sm representation designates the representation clause for that record type; if none is applicable then sm representation is void.

3.3.1.2.1.3 CONSTRAINED

A constrained array, record, or access type is represented by a node from class CONSTRAINED. The class CONSTRAINED defines the boolean attribute sm depends on dscrm t, which is true for a record component subtype which depends on a discriminant, and false in all other cases. The sm derived attribute for a constrained_array or constrained_record node is always void.

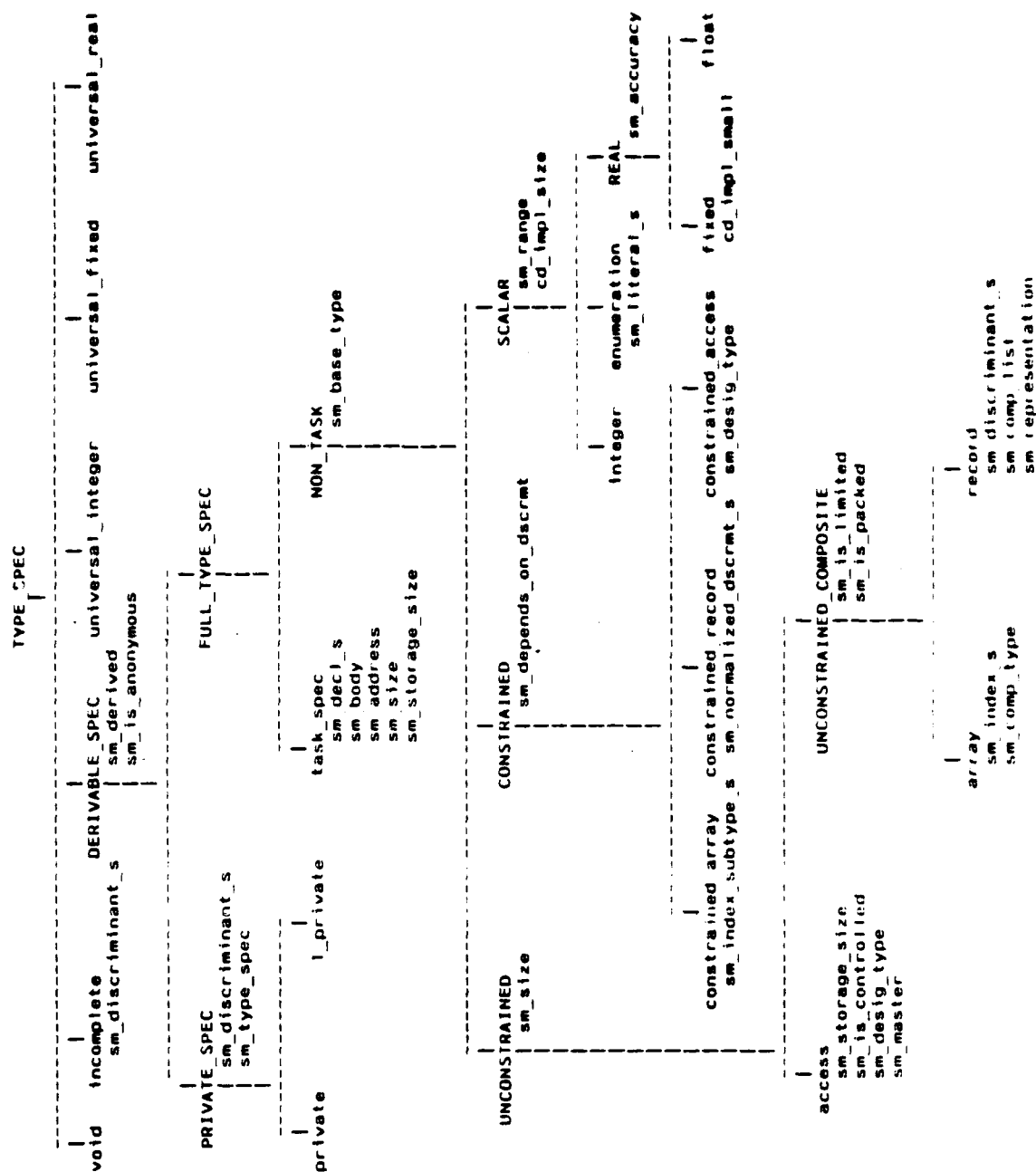
The constrained_array node defines an sm index subtype s attribute which denotes a sequence that does not correspond to source code. This sequence is a semantic representation of the index constraint, and is derived from the as discrete range s sequence of the index constraint node. The sm index subtype s sequence consists of integer and/or enumeration nodes, some of which may be created solely for this sequence. If a particular discrete range is given by a type mark then a new node is not created to represent that discrete range, the enumeration or integer node associated with the type mark is used. Otherwise, a new enumeration or integer node is created to represent the new anonymous index subtype.

The sm base type attribute of a constrained_array node always denotes an array node. If the type is introduced by a constrained array definition then an anonymous base type is created; i.e. the sm type spec attribute of the type_id node or the sm obj type attribute of the VC_NAME node denotes a constrained_array node which has an anonymous array node as its base type. If the constrained array definition is part of an object declaration then the constrained_array node will be anonymous as well. The array node representing the base type does not correspond to source code; its sm index s attribute is a sequence of undefined ranges which also are not derived from source code. The array node incorporates the information in the constrained array type definition pertaining to the component subtype, and the constrained_array node retains the constraint information.

A constrained_record node has an sm normalized dscrmt s attribute which is a normalized sequence of the expressions given in the discriminant constraint. No new nodes must be created in order to construct this sequence. The sm base type attribute of a constrained_record node may denote a node of type record, private, or l_private.

The constrained_access node represents a constrained access type or subtype. Its sm desig type attribute denotes the designated subtype. If the constrained_access node is introduced by either a type declaration in which the subtype indication contains an explicit constraint, or a subtype declaration that imposes a new constraint, then the designated subtype is a new anonymous subtype. The sm base type attribute of a constrained_access node references an access, private, or l_private node.

The constrained_array and constrained_access nodes may represent generic formal types, in which case the sm depends on dscrmt attribute is false.



Section 3.4

TYPE_DEF

3.4 TYPE_DEF

The nodes in class TYPE_DEF represent the following constructs in the source code:

- (a) a subtype indication
- (b) the portion of a type declaration following the reserved word "is"
- (c) the subtype indication or constrained array definition in an object declaration

With the exception of the nodes constrained_array_def and subtype_indication, the nodes in this class may be designated only by the as_type_def attribute of the type_decl node.

This class contains numerous nodes which do not define attributes of their own, their purpose being to differentiate the various kinds of type definitions. The nodes private_def and l_private_def correspond to private and limited private type definitions, respectively. The nodes formal_dscrt_def, formal_integer_def, formal_float_def, and formal_fixed_def correspond to generic formal scalar type definitions.

The node enumeration_def corresponds to an enumeration type definition; the attribute as_enum_literals denotes a sequence corresponding to the enumeration literals given in the definition.

The node record_def corresponds to a record type definition; as_comp_list is the component list given in the definition.

3.4.1 CONSTRAINED_DEF

The class CONSTRAINED_DEF consists of nodes representing source code containing a constraint, hence the attribute as_constraint is defined on this class.

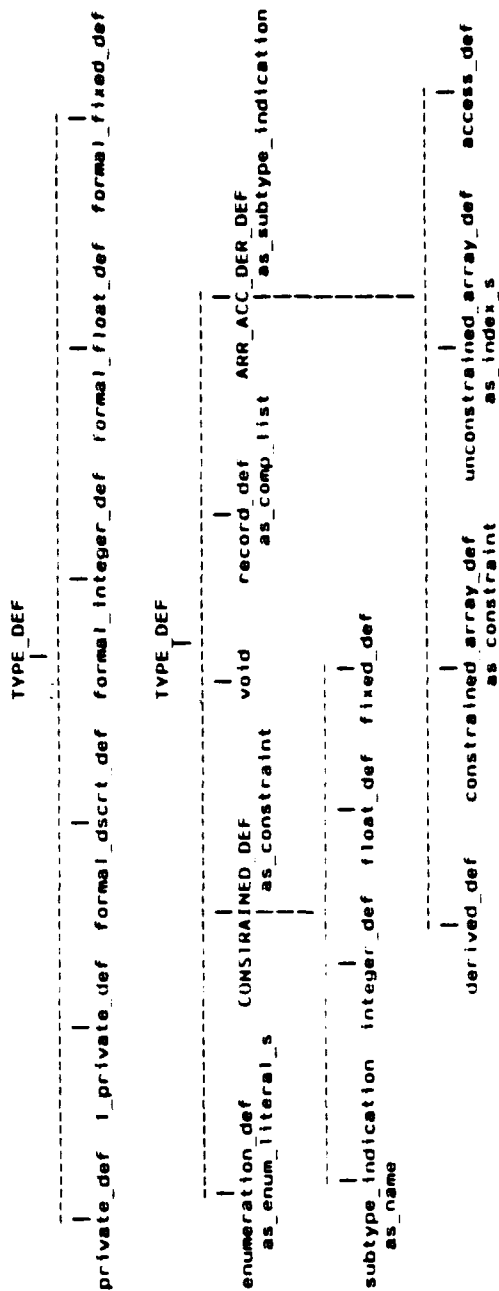
The nodes integer_def, float_def, and fixed_def correspond to numeric type definitions; the as_constraint attribute references a node representing the range constraint, floating point constraint, or fixed point constraint given in the definition.

The subtype_indication node records the occurrence of a subtype indication in the source code. It is never designated by the as type def attribute of a type_decl node; however, it may be referenced by the as type def attribute of an OBJECT_DECL node; or by the as subtype indication attribute of a subtype_decl, discrete_subtype, subtype_allocator, or ARR_ACC_DER_DEF node. The as constraint attribute denotes the constraint given in the subtype indication (if there is no constraint then this attribute is void), and as name represents the type mark.

3.4.2 ARR_ACC_DER_DEF

The class ARR_ACC_DER_DEF is composed of those nodes associated with type definitions containing a subtype indication; in particular, array type definitions, access type definitions, and derived type definitions. For an array definition the as subtype indication attribute denotes a node corresponding to the component subtype; for an access type definition as subtype indication is the designated subtype; for a derived type definition it is the parent subtype.

The nodes corresponding to array definitions each have an additional attribute. The unconstrained_array_def node has an as index s attribute which denotes a sequence representing the undefined ranges given in the unconstrained array definition. A constrained array definition is represented by the constrained_array_def node, which has an as constraint attribute corresponding to the sequence of discrete ranges given in the definition (an index_constraint node).



Section 3.5

CONSTRAINT

3.5 CONSTRAINT

The members of class **CONSTRAINT** represent discrete ranges and the various kinds of constraints defined by the Ada programming language (this class is the union of the Ada syntactic categories "discrete_range" and "constraint"). This class consists of the nodes index_constraint and dscrm_t_constraint, as well as the classes **DISCRETE_RANGE** and **REAL_CONSTRAINT**.

The node index_constraint represents an array index constraint. The attribute as discrete range s denotes a sequence of nodes representing the discrete ranges.

A discriminant constraint is represented by a dscrm_t_constraint node. The as general assoc s attribute corresponds to the sequence of discriminant associations (a sequence of nodes of type **named** and/or **EXP**).

3.5.1 DISCRETE_RANGE

The class **DISCRETE_RANGE** contains the node discrete_subtype and the class **RANGE**.

A discrete subtype indication is represented by a discrete_subtype node. The as subtype indication attribute references a node representing the subtype indication itself.

3.5.1.1 RANGE

The nodes which comprise class **RANGE** -- range, range_attribute, and void -- represent ranges and range constraints. The context determines whether a node belonging to class **RANGE** represents a range or a range constraint. If the node is introduced by an as constraint attribute then it represents a range constraint; otherwise it is simply a range.

The context also determines the value of the sm type spec attribute. For a **RANGE** node introduced by a subtype indication sm type spec refers to the **SCALAR** node associated with the type mark. If the **RANGE** node is introduced by a type definition or a derived type definition creating a new scalar type then sm type spec denotes the specification of the new base type. Otherwise sm type spec designates the node corresponding to the appropriate base type, as

specified by the Ada Reference Manual. For instance, sm base type of a RANGE node corresponding to a slice denotes the specification of the index type.

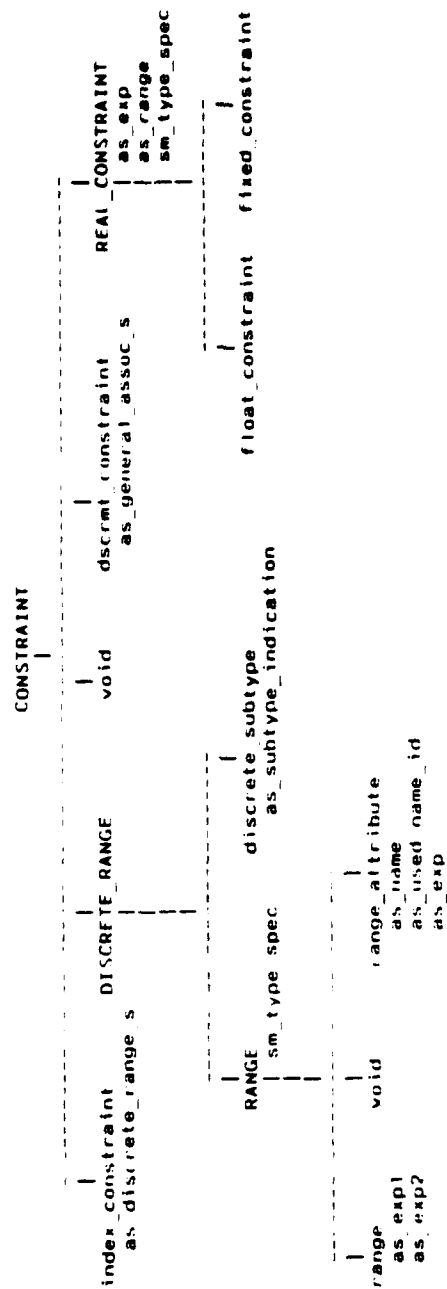
The range node corresponds to a range given by two simple expressions, which are denoted by the attributes as exp1 (the lower bound) and as exp2 (the upper bound).

The range_attribute node represents a range attribute. The as name attribute references the NAME node corresponding to the prefix, the attribute as used name id designates the attribute_id node for RANGE, and as exp denotes the argument specifying the desired dimension (if no argument is given then as exp is void).

3.5.2 REAL_CONSTRAINT

The class REAL_CONSTRAINT contains the nodes float_constraint and fixed_constraint, representing floating point constraints and fixed point constraints, respectively. This class defines two structural attributes: as exp and as range. The as exp attribute references the node representing the simple static expression for digits or delta. The attribute as range denotes the range given in the constraint; it may be void for floating point constraints and for fixed point constraints which do not correspond to fixed point type definitions.

The nodes belonging to REAL_CONSTRAINT also have an sm type spec attribute. If the REAL_CONSTRAINT node corresponds to a subtype indication then sm type spec of the REAL_CONSTRAINT node and the corresponding RANGE node (if there is one) denotes the type specification associated with the type mark. If the constraint is introduced by a real type definition or a derived type definition then sm type spec of the REAL_CONSTRAINT node and the RANGE node (if there is one) references the type specification of the new base type.



3.6.1.1 RENAME_INSTANT

The nodes in class RENAME_INSTANT indicate that a subprogram or a package has been renamed or instantiated. The meaning of the as name attribute which is defined on this class depends on whether the node is a renames_unit node or an instantiation node.

The node renames_unit represents the renaming of an entity as a subprogram or a package. The attribute as name denotes the name of the original entity as given in the renaming declaration. The valid values of as name are determined by the kind of entity being renamed; they are as follows:

- (a) package - selected or used_name_id
- (b) procedure - selected or used_name_id
- (c) function - selected or used_name_id
- (d) operator - selected or used_op
- (e) entry - selected or used_name_id or indexed
- (f) enumeration literal - selected or used_char or used_object_id
- (g) attribute - attribute

The instantiation node signifies the instantiation of a generic subprogram or package. The as name attribute designates a used_name_id or selected node corresponding to the name of the generic unit, and the as general assoc's attribute denotes a possibly empty sequence of parameter associations (nodes of type EXP and assoc). The sm decl's attribute of the instantiation node is a normalized list of the generic parameters, including entries for all default parameters.

Declarative nodes are used to represent the actual parameters in the sm decl's sequence. Each parameter has its own declarative node, and each declarative node introduces a new SOURCE_NAME node. The lx symrep attribute of each SOURCE_NAME node contains the symbol representation of the generic formal parameter; however, the values of the semantic attributes are determined by the actual parameter. None of the new nodes created during the process of constructing the sm decl's sequence represent source code.

The declarations are constructed as follows:

- (a) For every generic formal in parameter, a constant declaration is created. The as source name's sequence of the constant_decl node contains a single constant_id node. The as type def attribute is undefined, and the as exp attribute designates either the actual expression or the default expression of the generic parameter declaration.

The sm first attribute of the constant id node contains a self-reference (it does not refer to the in id of the generic formal object declaration), sm renames obj is false, and sm obj type denotes the TYPE SPEC node of the actual parameter (or default expression). The attribute sm init exp designates the same node as the as exp attribute of the constant_decl node.

- (b) For every generic formal in out parameter, a renaming declaration is created. The as source name attribute of the renames_obj_decl node denotes a new variable_id node, and the as type mark name attribute is undefined. The as name attribute designates the name of the actual parameter as given in the generic actual part.

The attribute values of the variable_id are determined exactly as if the declaration were a genuine renaming of the actual parameter as the formal parameter (see section 3.2.2.3.2.1).

- (c) For every generic formal type a subtype declaration is created. The as source name attribute of the subtype_decl node designates a new subtype_id node which has an sm type spec attribute denoting the TYPE SPEC node associated with the actual subtype. The subtype indication node designated by the as subtype indication attribute has a void as constraint attribute and an as name attribute which represents the type mark of the actual subtype.
- (d) For every generic formal subprogram, a new subprogram declaration is created. The subprog_entry_decl node is a renaming declaration, therefore the as unit kind attribute denotes a renames_unit node which references either the actual parameter or the appropriate default. The as header attribute denotes the HEADER node of the generic actual parameter.

The as source name attribute designates a new SUBPROG NAME or ENUM_LITERAL node, depending on the actual (or default) parameter. The kind of node and the values of its attributes (except for sm spec) are determined precisely as if the declaration were an explicit renaming of the actual entity as the formal subprogram (see sections 3.1.1.3.3.2.1 and 3.2.2.4.1.1.1). The sm spec attribute denotes the header of the actual parameter rather than that of the generic formal parameter declaration.

Once the normalized declaration list is constructed the specification part of the generic unit is copied; however, every reference to a formal parameter in the original generic specification is changed to a reference to the corresponding newly created declaration. In addition, all references to the discriminants of a formal type are changed to denote the corresponding discriminants of the newly created subtype (i.e. the discriminants of the actual type). All references to the formal parameters of a formal subprogram are changed to denote the corresponding parameters of the newly created subprogram (i.e. the formal parameters of the actual subprogram). The value of the as name attribute of a DSCRMT_PARAM_DECL node is undefined in this copy of the specification, as is the value of the as type def attribute of an OBJECT_DECL node.

The sm_spec attribute of the procedure_id, function_id, or package_id corresponding to the instantiated unit designates this new specification.

3.6.1.2 GENERIC_PARAM

The nodes in class GENERIC_PARAM are used to indicate that a subprogram is a generic formal parameter. The nodes name_default, box_default, and no_default comprise GENERIC_PARAM.

The name_default node signifies that a generic formal subprogram has an explicitly given default. The as name attribute represents the name of the default as given -- a node from class DESIGNATOR or an indexed node.

The node box_default indicates that a box rather than a name is given for the default; it defines no attributes of its own.

The no_default node records the fact that no default is specified; it defines no attributes of its own.

3.6.2 BODY

The class BODY represent unit bodies; it contains the nodes stub, block_body, and void.

The stub node corresponds to a body stub; it defines no attributes of its own.

The block_body node represents the contents of either a proper body or a block statement. It has three structural attributes -- as item s, as stm s, and as alternative s -- corresponding to the declarative part, the sequence of statements, and the exception handlers, respectively.

UNIT_DESC									
implicit_not_eq sm_equal		UNIT_KIND	derived_subprog sm_derivable		BODY				
void		void			block_body				
						as_item_s	as_stmt_s	as_alternative_s	
renames_unit		instantiation as_general sm_decl_s	name_default as_name	box_default	no_default				

Section 3.7

HEADER

3.7 HEADER

The nodes in class `HEADER` contain all of the information given in the specification of a subprogram, entry, or package except for the name of the entity. `HEADER` contains the node `package_spec` and the class `SUBP_ENTRY_HEADER`.

A `HEADER` node corresponding to either the renaming of a package or an instantiation will contain no information; i.e. any sequence attributes will denote empty sequences and any class-valued attributes will be void.

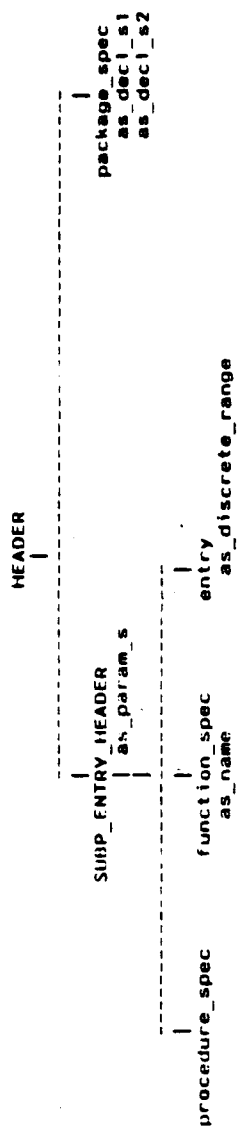
The node `package_spec` represents the declarative parts of a package specification. It has two semantic attributes -- `as decl s1` and `as decl s2` -- corresponding to the visible and private parts of the specification, respectively. Either or both of these sequences may be empty.

3.7.1 SUBP_ENTRY_HEADER

The nodes in class `SUBP_ENTRY_HEADER` record the information given in the formal part of a subprogram or entry declaration. This class defines an attribute `as param s` which denotes a possibly empty sequence of parameter specifications. The nodes `procedure_spec`, `function_spec`, and `entry` comprise `SUBP_ENTRY_HEADER`.

The node `function_spec` has an additional attribute, `as name`, representing the type mark given in the function specification. If the `function_spec` corresponds to the instantiation of a generic function then `as name` is void; otherwise it designates a `used_name_id` or a selected node.

The `entry` node has the attribute `as discrete range`, denoting the discrete range given in the entry declaration. If the declaration introduces a single entry rather than an entry family then `as discrete range` is void.



Section 3.8

GENERAL_ASSOC

3.8 GENERAL_ASSOC

The class **GENERAL_ASSOC** represents the following kinds of associations:

- (a) parameter
- (b) argument
- (c) generic
- (d) component
- (e) discriminant

The classes **NAMED_ASSOC** and **EXP** comprise **GENERAL_ASSOC**. If the association is given in named form then it is represented by a node from class **NAMED_ASSOC**; otherwise it is denoted by a node from class **EXP**.

3.8.1 NAMED_ASSOC

The **NAMED_ASSOC** class contains two nodes -- **named** and **assoc**. It defines an attribute as_exp which records the expression given in the association.

The **assoc** node corresponds to associations which contain a single name; i.e. parameter, argument, and generic associations. The as_used_name attribute represents the argument identifier or (generic) formal parameter given in the association.

The node **named** represents associations that may contain more than one choice -- component associations (of an aggregate) and discriminant associations (of a discriminant constraint). It defines an as_choices attribute which references a sequence of nodes representing the choices or discriminant names given in the association. The simple names of components or discriminants that occur within associations are represented by used_name_id nodes rather than used_object_id nodes.

3.8.2 EXP

The EXP class represents names and expressions; its three components are NAME, EXP, and void.

Certain names and expressions may introduce anonymous subtypes; i.e. slices, aggregates, string literals, and allocators. The anonymous subtype is represented by a constrained_array or a constrained_record node, and is designated by the sm exp type attribute of the expression introducing it. Anonymous index subtypes (for an anonymous array subtype) are introduced by discrete ranges which are not given by type marks. Subsequent sections will discuss in further detail the circumstances which produce an anonymous subtype, as well as the representation of the subtype.

3.8.2.1 NAME

The class NAME represents used occurrences of names; it contains the classes DESIGNATOR and NAME_EXP, and the node void.

3.8.2.1.1 DESIGNATOR

The nodes in class DESIGNATOR correspond to used occurrences of simple names, character literals, and operator symbols. DIANA does not require that each used occurrence of an identifier or symbol be represented by a distinct node (although it does allow such a representation); hence it is possible for a single instance of a node corresponding to a used occurrence to represent all of the logical occurrences of the associated identifier. Used occurrences of named numbers which occur in certain contexts are an exception to the previous statement; see section 3.8.2.1.1.1.

DESIGNATOR consists of the classes USED_OBJECT and USED_NAME, and defines the attributes sm defn and lx symrep. The sm defn attribute references the DEF_NAME node corresponding to the defining occurrence of the entity (if the entity is predefined the DEF_NAME node is not accessible through structural attributes). The lx symrep attribute is the string representation of the name of the entity.

3.8.2.1.1.1 USED_OBJECT

The class USED_OBJECT represents appearances of enumeration literals, objects, and named numbers. The sm defn attribute of a node from this class denotes a node from class OBJECT_NAME.

USED_OBJECT defines the attributes sm exp type and sm value. The sm exp type attribute denotes the subtype of the entity; i.e. the node designated by the sm obj type attribute of the defining occurrence of the entity. The sm value attribute records the static value of a constant scalar object; if the entity does not satisfy these conditions then sm value has a

distinguished value indicating that it is not evaluated.

The nodes used_char and used_object_id constitute this class; together they represent the used occurrences of all the entities having defining occurrences belonging to class OBJECT_NAME. The used_char node represents a used occurrence of a character literal; a used_object_id node represents the use of an object, an enumeration literal denoted by an identifier, or a named number. The sm_defn attribute of a used_char node references a character_id, the sm_defn attribute of a used_object_id may designate any node from class OBJECT_NAME except for a character_id.

Although the names of objects most often occur in expressions, the names of certain objects -- those of record components (including discriminants) and parameters -- may also occur on the left-hand side of named associations; these instances are represented by used_name_id nodes rather than used_object_id nodes.

The use of the new name of an enumeration literal renamed as a function is represented by a used_char or used_object_id node rather than a function_call node.

If a used_object_id corresponds to a named number, and the use represented by the used_object_id occurs in a context requiring an implicit type conversion of the named number, then the sm_exp_type attribute of the used_object_id denotes the target type rather than a universal type. This means that it is not always possible for a single used occurrence of a named number to represent all used occurrences of that named number; however, a single used occurrence having a particular target type CAN represent all used occurrences of that named number requiring that particular target type.

3.8.2.1.1.2 USED_NAME

The class USED_NAME represents used occurrences of identifiers or symbols corresponding to entities which do not have a value and a type. It contains the node used_op and used_name_id.

The node used_op represents the use of an operator symbol, hence its sm_defn attribute denotes either an operator_id or a bltn_operator_id.

A used_name_id node represents a use of the name of any of the remaining kinds of entities. It may also record the occurrence of the simple name of a discriminant, a component, or a parameter on the left-hand side of a named association (however, it does not denote a used occurrence of such an object in any other context). Excluding this special case, sm_defn may reference any member of class DEF_NAME except for an operator_id, a bltn_operator_id, or a member of class OBJECT_NAME.

3.8.2.1.2 NAME_EXP

The nodes in class NAME_EXP represent names which are not simple identifiers or character symbols; i.e. function calls and names having a prefix. The attributes as name and sm exp type are defined for the nodes in this class. The as name attribute represents either the name of the function or the prefix.

If the NAME_EXP node corresponds to an expression then sm exp type corresponds to the subtype of the entity, otherwise it is void. The only NAME_EXP nodes which can possibly have a void sm exp type attribute are the indexed, attribute, and selected nodes.

The node all represents a dereferencing; i.e. a selected component formed with the selector "all". The as name attribute corresponds to the access object, and sm exp type is the designated subtype.

The indexed node represents either an indexed component or a reference to a member of an entry family. For an indexed component the as exp s attribute denotes a sequence of index expressions, as name is the array prefix, and sm exp type is the component subtype. The as exp s attribute of an entry family member is a one-element sequence containing the entry index; as name is the entry name, and sm exp type is void.

A slice is represented by a slice node. The as name attribute denotes the array prefix and the as discrete range attribute is the discrete range.

The sm exp type attribute denotes the subtype of the slice. The subtype of a slice is anonymous unless it can be determined statically that the bounds of the slice are identical to the bounds of the array prefix, in which case the sm exp type attribute of the slice node is permitted to reference the constrained array node associated with the array prefix. Otherwise, an anonymous subtype is created for the slice node. The anonymous subtype is represented by a constrained array node having the same base type as that of the array prefix; however, the constraint is taken from the discrete range given in the slice.

3.8.2.1.2.1 NAME_VAL

The class NAME_VAL contains NAME_EXP nodes which may have a static value, consequently the sm value attribute is defined for the nodes in this class. If the value is not static, sm value has a distinguished value indicating that the expression is not evaluated. NAME_VAL comprises the nodes attribute, selected, and function call.

The node attribute corresponds to an Ada attribute other than a RANGE attribute (which is represented by a range attribute node). The DIANA attribute as name denotes the prefix, as used name references the attribute id corresponding to the given attribute name, and as exp is the universal static expression. If no universal expression is present then as exp is void.

The value of the sm_exp_type attribute of an attribute node depends on the kind of Ada attribute it represents, as well as the context in which it occurs. If the attribute node represents the BASE attribute then sm_exp_type is void. If the Ada attribute returns a value of a universal type, and that value is the object of an implicit type conversion (determined by the context), then sm_exp_type references the target type. Otherwise sm_exp_type denotes the TYPE_SPEC node corresponding to the type of the attribute as specified in the Ada Reference Manual.

The node selected represents a selected component formed with any selector other than the reserved word "all" (this includes an expanded name). The as_name attribute denotes the prefix, and as_designator corresponds to the selector. If the selected node represents an object (i.e. an entity having a value and a type, for instance a record component) then sm_exp_type is the subtype of the object; otherwise it is void.

All function calls and operators are represented by function call nodes, with the exception of the short circuit operators and the membership operators. The as_name attribute denotes the name of the function or operator -- a used_name_id, used_op, or selected node. The lx_prefix attribute records whether the function call is given using infix or prefix notation. The as_general_assoc_s attribute is a possibly empty sequence of parameter associations (nodes of type EXP and assoc); sm_normalized_params is a normalized list of actual parameters, including any expressions for default parameters. The sm_exp_type attribute denotes the return type. If the function call corresponds to a predefined operator then sm_exp_type references the appropriate base type, as specified in section 4.5 of the Ada Reference Manual.

Although the use of an enumeration literal is considered to be equivalent to a parameterless function call, it is represented by a used_char or used_object_id node rather than a function call node (this includes the use of an enumeration literal renamed as a function). However, the use of an attribute renamed as a function is represented by a function_call node, not an attribute node.

3.8.2.2 EXP_EXP

The class EXP_EXP represents expressions which are not names. The attribute sm_exp_type which is defined on this class denotes the TYPE_SPEC node corresponding to the subtype of the expression. EXP_EXP contains the nodes qualified_allocator and subtype_allocator as well as the classes AGG_EXP and EXP_VAL.

The nodes qualified_allocator and subtype_allocator represent the two forms of allocators. Each node has the appropriate structural attribute -- as qualified or as subtype indication -- to retain the information given in the allocator. The sm_exp_type attribute denotes the TYPE_SPEC node corresponding to the subtype of the access value to be returned, as determined from the context. The subtype_allocator defines an additional attribute, sm_desig_type, which denotes a TYPE_SPEC node corresponding to the subtype of the object created by the allocator. If the subtype indication contains an explicit constraint then sm_desig_type denotes a new TYPE_SPEC node corresponding to the

anonymous subtype of the object created by the allocator.

3.8.2.2.1 AGG_EXP

The AGG_EXP class represents aggregates and string literals; it is composed of the nodes aggregate and string_literal. The aggregate node may represent an aggregate or a subaggregate. The string_literal node represents a string literal (which may also be a subaggregate if it corresponds to the last dimension of an aggregate corresponding to a multidimensional array of characters).

The class AGG_EXP defines an sm discrete range attribute to represent the bounds of a subaggregate; sm discrete range is void for a node representing an aggregate. The sm exp type attribute of a node corresponding to an aggregate denotes the subtype of the aggregate; it is void for a subaggregate. This implies that in an aggregate or string_literal node exactly one of these two attributes is void.

If sm exp type is not void, it designates a constrained_array or constrained_record node corresponding to the subtype. An aggregate or a string literal has an anonymous subtype unless it can be determined statically that the constraints on the aggregate are identical to those of the subtype obtained from the context, in which case sm exp type may (but does not have to) reference the node associated with that subtype.

If the aggregate has an anonymous subtype it is constructed from the base type of the context type and the bounds as determined by the rules in the Ada Reference Manual. If the bounds on the subaggregates for a particular dimension of a multidimensional aggregate are not the same (a situation which will result in a CONSTRAINT ERROR during execution) DIANA does not specify the subaggregate from which the bounds for the index constraint are taken.

The string_literal node defines only one additional attribute, lx symrep, which contains the string itself.

The aggregate node has two different representations of the sequence of component associations; both may contain nodes of type named and EXP. The as general assoc s attribute denotes the sequence of component associations as given; sm normalized comp s is a sequence of normalized component associations which are not necessarily in the same form as given, for the following reasons:

- (a) Each named association having multiple choices is decomposed into separate associations for the sm normalized comp s sequence, one for each choice in the given association; hence the as choice s sequence of a named node in the normalized list contains only one element. The manner in which this decomposition is done is not specified, the only requirements being that the resulting associations be equivalent, and that each association be either the component expression itself or a named association with only one choice. Consider the array aggregate

(1 | 2 | 3 => 10)

The named association could be broken down in such a way that the sm normalized comp s sequence appeared as if it came from any of the following aggregates:

(1 => 10, 2 => 10, 3 => 10)
(1..3 => 10)
(10, 10, 10)

In the process of normalizing the component associations new named nodes may be created, and duplication of the component expressions is optional. For the remainder of this section all named component associations will be treated as if they had only one choice.

- (b) For a record aggregate, if a choice is given by a component name then the component expression rather than the named node is inserted in the proper place in the sequence, hence the normalized sequence for a record aggregate is actually a sequence of EXP nodes.
- (c) In an array aggregate an association containing a choice which is a simple expression may be replaced by the component expression if it can be determined statically that the choice belongs to the appropriate index subtype (this substitution is optional).
- (d) A named association with an "others" choice is not allowed in the sm normalized comp s sequence. For each component or range of components denoted by the "others" either a component expression is inserted in the proper spot in the sequence, or a new named node is created containing the appropriate range.

Due to some of the changes mentioned above it is possible for the sm normalized comp s sequence of an array aggregate to contain a mixture of EXP and named nodes.

3.8.2.2.2 EXP_VAL

The EXP_VAL class contains nodes representing expressions which may have static values, hence the sm value attribute is defined for the nodes in this class. If the value is not static then sm value has a distinguished value which indicates that the expression is not evaluated.

A numeric literal is represented by a numeric_literal node. It has an attribute lx numrep containing the numeric representation of the literal. If the literal is the object of an implicit conversion then sm exp type denotes the target type rather than a universal type.

The null access node corresponds to the access value NULL; it defines no attributes of its own. Although a distinct null access node may be created for each occurrence of the access value NULL, DIANA also permits a single null access node to represent all occurrences of the literal NULL for that particular access type.

The node short_circuit represents the use of a short circuit operator. The as short circuit op attribute denotes the operator (and_then or or_else); as exp1 and as exp2 represent the expressions to the left and right of the operator, respectively.

3.8.2.2.2.1 EXP_VAL_EXP

The class EXP_VAL_EXP defines an as exp attribute; it comprises the node parenthesized and the classes MEMBERSHIP and QUAL_CONV.

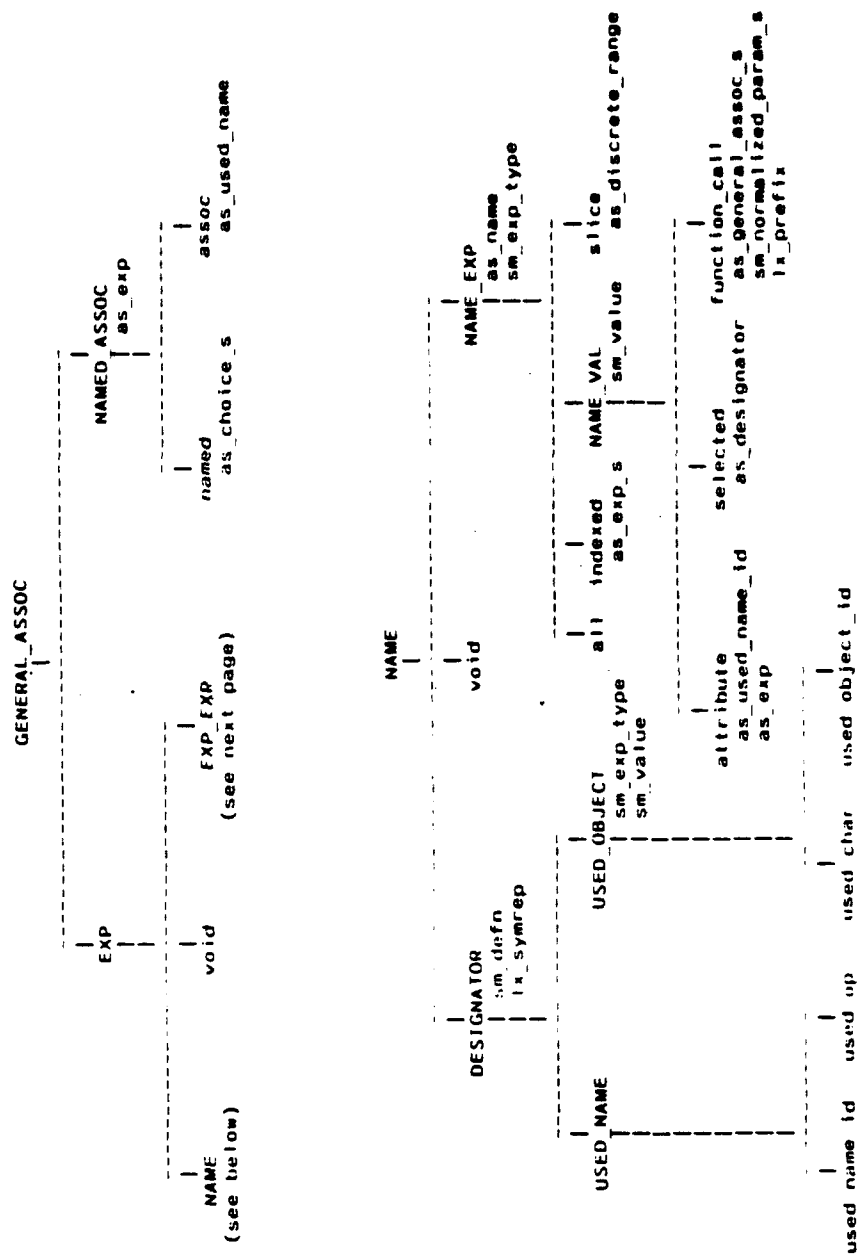
The parenthesized node represents a pair of parentheses enclosing an expression. The as exp attribute denotes the enclosed expression, sm value is the value of the expression if it is static, and sm exp type is the subtype of the expression. A parenthesized node can NEVER be denoted by a semantic attribute, nor can it be included directly in a sequence that is constructed exclusively for a semantic attribute (such as a normalized sequence); the node representing the actual expression is referenced instead.

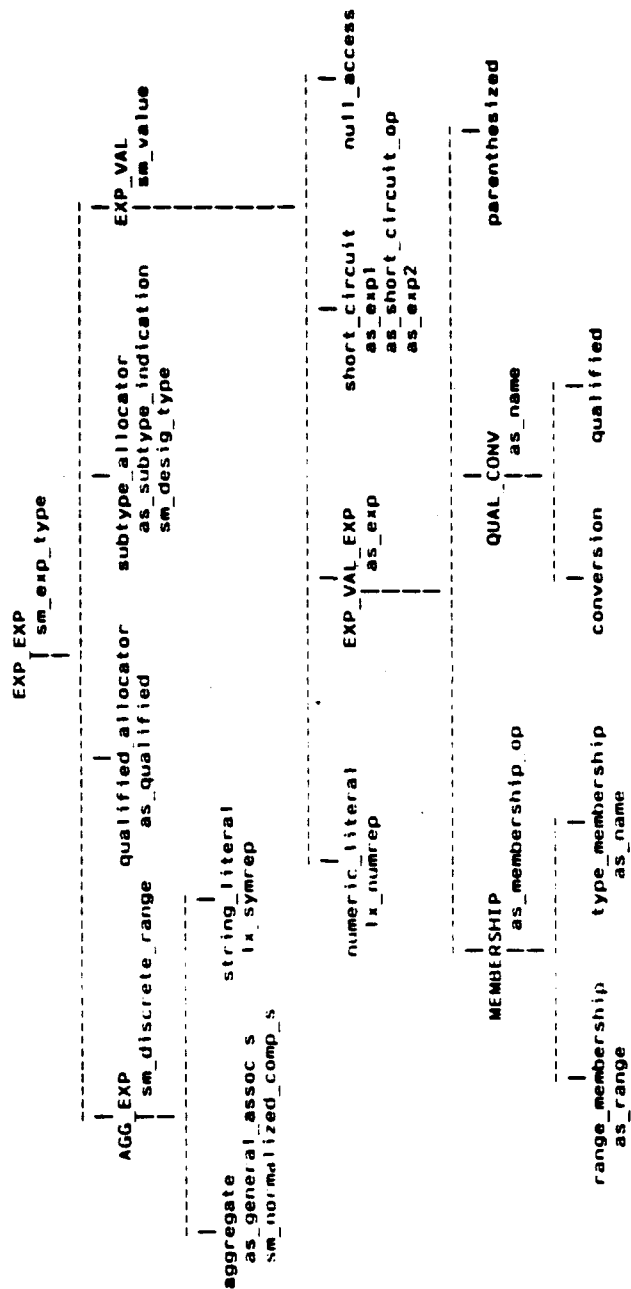
3.8.2.2.2.1.1 MEMBERSHIP

The class MEMBERSHIP represents the use of a membership operator. The attribute as exp records the simple expression, and the as membership attribute denotes the applicable membership operator (in_op or not_in). MEMBERSHIP contains two nodes: range_membership and type_membership. Each contains the appropriate structural attribute to retain the type or range given in the expression.

3.8.2.2.2.1.2 QUAL_CONV

The nodes in class QUAL_CONV -- qualified and conversion -- correspond to qualified expressions and explicit conversions, respectively. The as exp attribute denotes the given expression or aggregate, and as name references the node associated with the type mark. The sm exp type attribute denotes the TYPE_SPEC node corresponding to the type mark.





Section 3.9

STM_ELEM

3.9 STM_ELEM

The class **STM_ELEM** contains nodes representing items which may appear in a sequence of statements; i.e. nodes corresponding to statements or pragmas.

The node **stm_pragma** represents a pragma which appears in a sequence of statements. Its only non-lexical attribute, as pragma, designates a **pragma** node.

3.9.1 STM

A node from class **STM** represents an Ada statement. Some of the **STM** nodes are grouped together because they are similar in their structure to other nodes in the class; the manner in which these nodes are classified does not imply any semantic similarity.

The node **null_stm** represents a NULL statement; it defines no attributes of its own.

The node **labeled** represents a labeled statement. The as source name s attribute denotes a sequence of label names (**label_id** nodes). These label names are defining occurrences, hence the **labeled** node serves as a "declaration" for the associated labels. The as pragma s attribute represents the pragmas occurring between the label(s) and the statement itself; it designates a possibly empty sequence of **pragma** nodes. The as stm attribute denotes the actual statement, it may reference any type of **STM** node other than another **labeled** node.

The **accept** node represents an accept statement. The as name attribute records the entry simple name; it may denote either a used_name_id or an **indexed** node, depending on whether or not the entry is a member of an entry family. The attribute as param s denotes a possibly empty sequence of nodes from class **PARAM** corresponding to the formal part. The as stm s attribute is a possibly empty sequence representing the statements to be executed during a rendezvous.

The **abort** node represents an abort statement. The as name s attribute is a sequence of nodes corresponding to the task names given in the abort statement.

The node **terminate** corresponds to a terminate statement; it defines no attributes of its own.

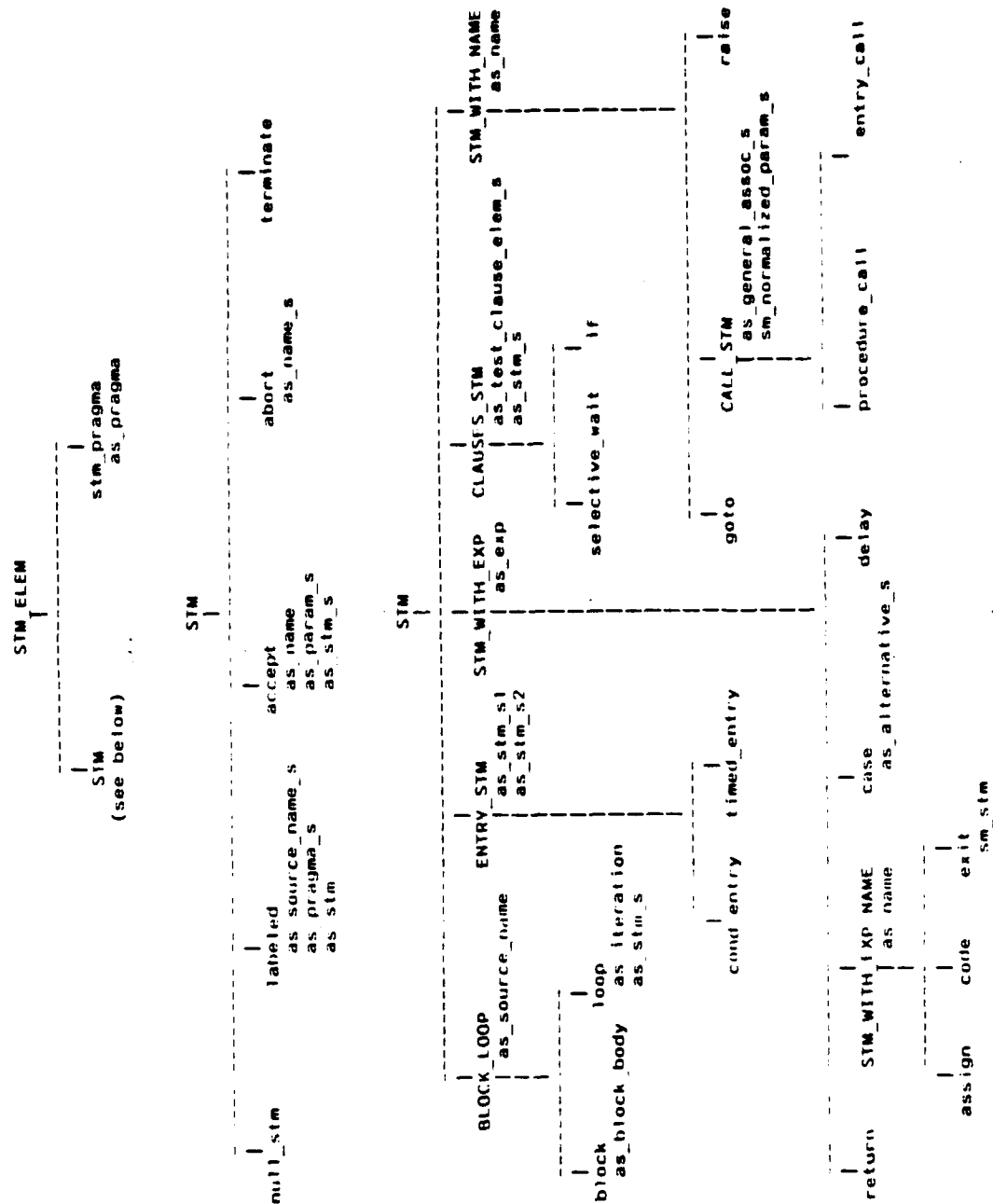
The node `goto` represents a `goto` statement. The as name attribute corresponds to the label name given in the statement.

The `raise` node represents a `raise` statement. The attribute as name denotes the exception name, if specified; otherwise it is `void`.

3.9.1.5.1 CALL_STM

The class `CALL_STM` represents procedure calls and entry calls; it comprises the nodes `procedure_call` and `entry_call`. `CALL_STM` defines two attributes: as general assoc s and sm normalized param s. The attribute as general assoc s denotes a possibly empty sequence containing a mixture of `assoc` and `EXP` nodes representing the parameter associations. The sm normalized param s attribute designates a possibly empty sequence corresponding to a normalized list of actual parameters.

A call to an entry that has been renamed as a procedure is represented by a `procedure_call` node rather than an `entry_call` node.



Section 3.10

MISCELLANEOUS NODES AND CLASSES

3.10 MISCELLANEOUS NODES AND CLASSES

3.10.1 CHOICE

A node from class CHOICE represents either the use of a discriminant simple name in a discriminant association, or a choice contained in one of the following:

- (a) a record variant
- (b) a component association of an aggregate
- (c) a case statement alternative
- (d) an exception handler

Nodes in this class may appear only as a part of a sequence of choice nodes. CHOICE comprises the nodes choice_exp, choice_range, and choice_others.

The node choice_exp represents a choice that is a simple name or an expression; it has a single structural attribute -- as_exp. If the choice_exp node corresponds to a simple name (that of a discriminant, a component, or an exception) then as_exp references a used_name_id node. Otherwise, choice_exp must represent a choice consisting of a simple expression, which is represented by a node from class EXP.

A choice which is a discrete range is represented by a choice_range node. The as_discrete_range attribute references the discrete range.

A choice_others node corresponds to the choice "others"; it defines no attributes of its own.

3.10.2 ITERATION

The members of class ITERATION -- while, FOR_REV, and void -- represent the iteration schemes of a loop (void corresponds to the absence of an iteration scheme). These nodes are introduced by the as_iteration attribute of a loop node.

The **while** node represents a "while" iteration scheme. The as exp attribute denotes a node representing the given condition.

3.10.2.1 FOR_REV

The **FOR_REV** class represents a "for" iteration scheme. If the reserved word "reverse" appears in the loop parameter specification then the iteration is represented by a **reverse** node; otherwise it is denoted by a **for** node. The as source name attribute designates an iteration_id corresponding to the defining occurrence of the loop parameter. The as discrete range attribute represents the discrete range.

3.10.3 MEMBERSHIP_OP

The class **MEMBERSHIP_OP** consists of the nodes **in_op** and **not in**. These nodes are introduced by the as membership op attribute of a **MEMBERSHIP** node, their function being to indicate which operator is applicable.

3.10.4 SHORT_CIRCUIT_OP

The nodes in class **SHORT_CIRCUIT_OP** -- **and then** and **or else** -- serve to distinguish the two types of short-circuit expressions. They are introduced by the as short circuit op attribute of the **short_circuit** node.

3.10.5 ALIGNMENT_CLAUSE

The class **ALIGNMENT_CLAUSE** represents the alignment clause portion of a record representation clause. It is composed of the nodes **alignment** and **void** (**void** corresponds to the absence of an alignment clause).

The **alignment** node contains the attributes as pragma s and as exp. The former is a possibly empty sequence of **pragma** nodes corresponding to the pragmas occurring between the reserved word "record" and the alignment clause. The as exp attribute refers to the node associated with the static simple expression.

3.10.6 VARIANT_PART

The **VARIANT_PART** class represents the variant part of a record type definition; it contains the nodes **variant_part** and **void** (**void** corresponds to the absence of a variant part).

The variant_part node defines the attributes as_name and as_variant_s. The as_name attribute references a used_object_id corresponding to the discriminant simple name; as_variant_s is a sequence containing at least one variant node and possibly variant_pragma nodes.

3.10.7 TEST_CLAUSE_ELEM

The class TEST_CLAUSE_ELEM represents alternatives for an if statement or a selective wait statement. It contains the node select_alt_pragma and the class TEST_CLAUSE. These nodes may appear only in a test_clause_elem_s sequence.

The node select_alt_pragma represents a pragma which occurs at a place where a select_alternative is allowed. It may appear only in a test_clause_elem_s sequence of a selective_wait node. The as_pragma attribute denotes the pragma itself.

3.10.7.1 TEST_CLAUSE

A TEST_CLAUSE node (cond_clause or select_alternative) represents a condition and sequence of statements occurring in an if statement or a selective wait statement. The as_exp attribute corresponds to the condition, and the as_stm_s attribute to the sequence of statements. The cond_clause node may appear only in a test_clause_elem_s sequence of an if node, and the select_alternative node may occur only in a test_clause_elem_s sequence of a selective_wait node.

3.10.8 ALTERNATIVE_ELEM

The class ALTERNATIVE_ELEM represents case statement alternatives, exception handlers, and pragmas which occur at a place where either of the previous items are allowed. The nodes alternative and alternative_pragma constitute ALTERNATIVE_ELEM; they may occur only as members of alternative_s sequences.

The alternative_pragma node has a single structural attribute, as_pragma, which denotes the pragma.

The alternative node contains two non-lexical attributes: as_choice_s and as_stm_s. For a case statement alternative the as_choice_s sequence may contain any of the nodes belonging to class CHOICE; however, for an exception handler the sequence is restricted to containing choice_exp and choice_others nodes. The as_stm_s attribute represents the sequence of statements given in the alternative or handler.

3.10.9 COMP_REP_ELEM

The class COMP_REP_ELEM consists of the nodes comp_rep and comp_rep_pragma, which may appear only in the as comp_rep s sequence of a record_rep node.

The comp_rep node represents a component representation clause. The as name attribute references a used_object_id corresponding to the component simple name, as exp represents the static simple expression, and as range denotes the static range.

A pragma that occurs at the place of a component clause is represented by a comp_rep_pragma node; as pragma denotes the pragma.

3.10.10 CONTEXT_ELEM

The nodes in class CONTEXT_ELEM represent items which may appear at a place where a context clause is allowed. They may occur only as members of the context_elem_s sequence of a compilation_unit node.

The with node represents a with clause and any subsequent use clauses and pragmas. The as name s attribute is a sequence of used_name_id nodes corresponding to the library unit names given in the with clause. The as use pragma s attribute is a possibly empty sequence which can contain nodes of type use and pragma.

The context_pragma node has a single non-lexical attribute, as pragma, which denotes the pragma.

3.10.11 VARIANT_ELEM

The nodes in class VARIANT_ELEM correspond to items which may appear at a spot where a variant is allowed. These nodes are contained in the sequence denoted by the as variant s attribute of the variant_part node.

The variant node has two structural attributes: as choice s and as comp list. The as choice s attribute is a sequence representing the choices applicable to that particular variant; as comp list corresponds to the component list.

The sole non-lexical attribute of the variant_pragma node is as pragma, denoting the pragma.

3.10.12 compilation

The node compilation corresponds to a compilation; it defines the attribute as compltn unit s, a possibly empty sequence of compilation_unit nodes.

3.10.13 compilation_unit

A compilation_unit node represents an item or items which may appear at a place where a compilation unit is allowed; i.e. it may represent a compilation or a sequence of pragmas.

A compilation_unit node represents a sequence of pragmas only when a compilation consists of pragmas alone. In this case the as context elem s sequence is empty, the as all decl attribute is void, and as pragma s denotes the sequence of pragmas which constitute the compilation.

For a compilation_unit node corresponding to a compilation unit the as context elem s attribute is a possibly empty sequence representing the context clause and any pragmas preceding the compilation unit. The as all decl attribute denotes the library unit or the secondary unit, which may be represented by one of the following: a node belonging to class UNIT_DECL, a subunit, a subprogram body, or a package body. The as pragma s attribute denotes the pragmas which follow the compilation unit and do not belong to a subsequent compilation unit. The pragmas allowed to appear in this sequence include INLINE, INTERFACE, LIST, and PAGE. LIST and PAGE pragmas which occur between compilation units but after any INLINE or INTERFACE pragmas may appear in either the as pragma s sequence of the preceding compilation unit or the as context elem s sequence of the succeeding compilation unit.

3.10.14 comp_list

A record component list is represented by a comp_list node, which contains three structural attributes: as decl s, as variant part, and as pragma s. The as decl s attribute designates a sequence corresponding to either a series of component declarations or the reserved word "null". The attribute as variant part denotes the variant part of the record, if one exists. The as pragma s attribute records the occurrence of pragmas between the variant part and the end of the record declaration (i.e. pragmas appearing between "end case" and "end record").

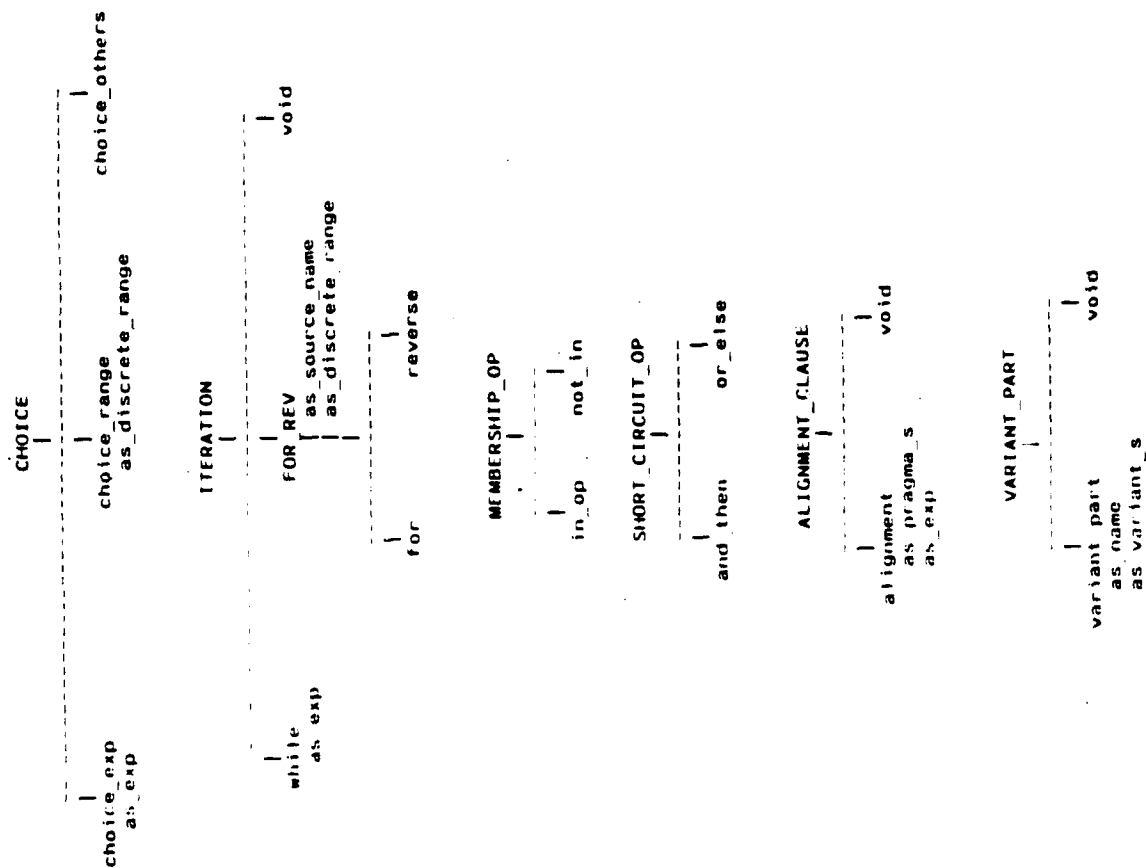
If the record is a null record then as variant part is void, and the sequence denoted by as pragma s is empty. The as decl s attribute is a sequence having a null_comp_decl node as its first element, and any number of pragma nodes after it.

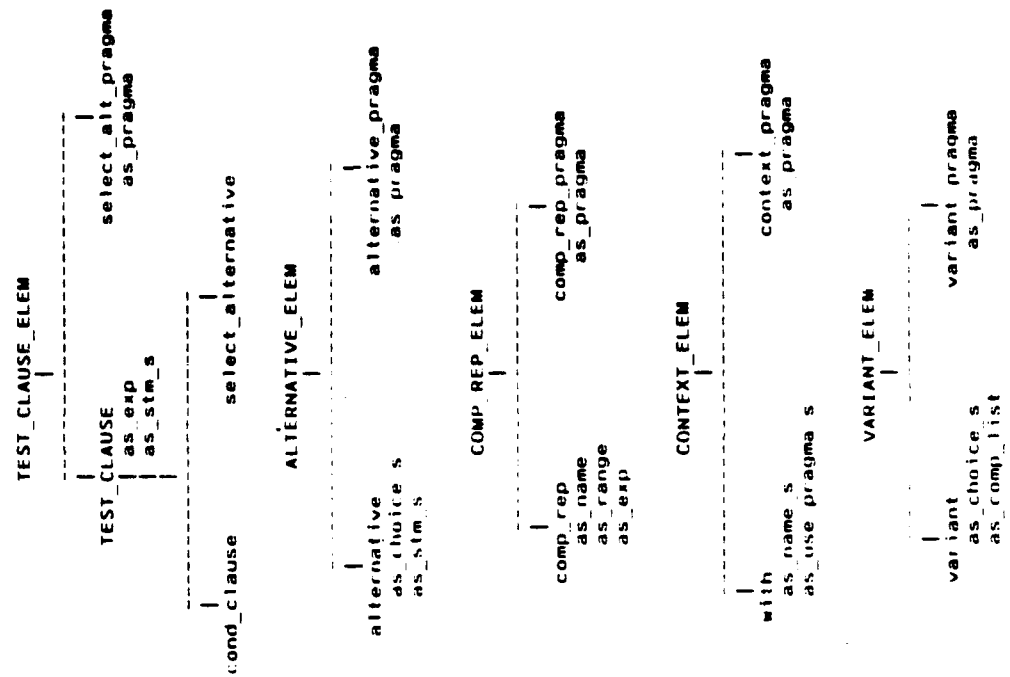
If the record is not a null record then as decl s is a possibly empty sequence which can contain nodes of type variable_decl and pragma. If the record type does not have a variant part then as variant part is void and as pragma s is empty. It is not possible for as decl s to be empty and as variant part to be void in the same comp_list node.

3.10.15 index

The index node represents an undefined range, and appears only in sequences associated with unconstrained array types and unconstrained array definitions

(such sequences are denoted by the as index s attribute of the the array and the unconstrained_array_def nodes). The as name attribute refers to the used_name_id or selected node corresponding to the type mark given in the index subtype definition. The sm type spec attribute references the TYPE_SPEC node associated with the type mark.





compilation
as_compltn_unit_s

compilation_unit
as_context_elem_s
as_all_dec
as_pragma_s

comp_list
as_dec_s
as_variant_part
as_pragma_s

index
as_name
sm_type_spec

CHAPTER 4
RATIONALE

Section 4.1

DESIGN DECISIONS

4.1 DESIGN DECISIONS

During the course of designing DIANA many design decisions were affected by the need to adhere to the design principles set forth in the first chapter of this document. This section discusses some of these decisions and the reasons that they were made. Each subsection explains the design decisions pertaining to a particular design principle.

4.1.1 INDEPENDENCE OF REPRESENTATION

One of the major design principles of DIANA requires that the definition of DIANA be representation independent. Unfortunately, some of the information which should be included in a DIANA structure is implementation-dependent. For example, DIANA defines a source position attribute for each node which represents source code. This attribute is useful for reconstructing the source program, for reporting errors, for source-level debuggers, and so on. It is not, however, a type that should be defined as part of this standard since each computer system has idiosyncratic notions of how a position in the source program is encoded. For that matter, the concept of source position may not be meaningful if the DIANA arises from a syntax editor. For these reasons, attributes such as source position are merely defined to be private types.

A private type names an implementation-specific data structure that is inappropriate to specify at the abstract structure level. DIANA defines six private types. Each of these corresponds to one of the kinds of information which may be installation or target machine specific. They include types for the source position of a node, the representation of identifiers, the representation of various values on the target system, and the representation of comments from the source program. The DIANA user must supply an implementation for each of these types.

As is explained in the Ada reference manual, a program is assumed to be compiled in a 'standard environment'. An Ada program may explicitly or implicitly reference entities defined in this environment, and the DIANA representation of the program must reflect this. The entities that may be referenced include the predefined attributes and types. The DIANA definition of these entities is not given in this document but is assumed to be available.

4.1.1.1 SEPARATE COMPILE

It would not be appropriate for DIANA to provide the library management upon which separate compilation of Ada program units is based. Nonetheless, the possibility of separate compilation affects the design of DIANA. The intermediate representation of a previously compiled unit may need to be used again. Furthermore, all of the information about a program unit may not be known when it is first compiled.

The design of DIANA carefully avoids constraints on a separate compilation system, aside from those implied directly by the Ada language. The design can be extended to cover the full APSE requirements[3]. Special care has been taken that several versions of a unit body can exist corresponding to a single specification, that simultaneous compilation within the same project is possible, and that units of other libraries can be used effectively [5]. The basic decision which makes these facilities implementable is to forbid forward references.

Certain entities may have more than one definition point in Ada. In such cases, DIANA restricts the attribute values of all of the defining occurrences to be identical. In the presence of separate compilation the requirement that the values of the attributes at all defining occurrences are the same cannot always be met. The forward references assumed by DIANA are void in these cases. The reasons for this approach are:

- o A unit can be used even when the corresponding body is not yet compiled. In this case, the forward reference must have the value void since the entity does not exist.
- o Updating a DIANA representation would require write access to a file which may cause synchronization problems (see [5]).
- o A library system may allow for several versions of bodies for the same specification. If an attribute were updated its previous value would be overwritten. Moreover, the maintenance of different versions should be part of the library system and should not influence the intermediate representation.

4.1.2 EFFICIENT IMPLEMENTATION AND SUITABILITY FOR VARIOUS KINDS OF PROCESSING

The design goals of efficient realization and suitability for many kinds of processing are interrelated. It was necessary to define a structure containing the information needed to perform different kinds of processing without overburdening any one kind of processing with the task of computing and retaining a great deal of extraneous information.

Since many tools will be manipulating the source text in some way, it was decided that DIANA should retain the structure of the original source program. In order to do this, structural attributes were defined. These attributes define a tree representing the original source. It is always possible to regenerate the source text from its DIANA form (except for purely lexical

issues, such as the placement of comments) by merely traversing the nodes denoted by structural attributes.

Unfortunately, the structure of the original source program is not always suitable for semantic processing. Hence, semantic attributes were added to augment the structural ones. These attributes transform the DIANA structure from a tree to a network. In some cases these attributes are merely "shortcuts" to nodes which are already in the DIANA structure, but in other cases semantic attributes denote nodes which do not correspond to source text at all.

In the process of adding semantic attributes to the definition of DIANA, it was necessary to decide which information should be represented explicitly and which should be recomputed from stored information. Obviously, storing as little information as possible makes the DIANA representation smaller; however, such an approach also increases the time required for semantic processing. Storing all of the information required would improve processing speed at the expense of storage requirements. The attribution principles of DIANA are a compromise between these extremes.

In order to decide whether or not to include a particular attribute the following criteria were considered:

- o DIANA should contain only such information as would be typically discovered via static (as opposed to dynamic) semantic analysis of the original program.
- o If information can be easily recomputed, it should be omitted.

These two points are discussed at length in the following two subsections.

4.1.2.1 STATIC SEMANTIC INFORMATION

DIANA includes only the information that is determined from STATIC semantic analysis, and excludes information whose determination requires DYNAMIC semantic analysis.

This decision affects the evaluation of non-static expressions and evaluation of exceptions. For example, the attribute sm_value should not be used to hold the value of an expression that is not static, even if an implementation's semantic analyzer is capable of evaluating some such expressions. Similarly, exceptions are part of the execution (i.e. dynamic) semantics of Ada and should not be represented in DIANA. Thus the attribute sm_value is not used to represent an exception to be raised.

Of course, an implementation that does compute these additional values may record the information by defining additional attributes. However, any DIANA consumer that relies on these attributes cannot be considered a correct DIANA "user", as defined in this document.

4.1.2.2 WHAT IS 'EASY TO RECOMPUTE'?

Part of the criteria for including an attribute in DIANA is that it should be omitted if it is easy to recompute from the stored information. It is important to avoid such redundant encodings if DIANA is to remain an implementable internal representation. Of course, this guideline requires a definition of this phrase.

An attribute is easily computed if:

- o it requires visits to no more than three to four nodes; or
- o it can be computed in one pass through the DIANA tree, and all nodes with this attribute can be computed in the same pass.

The first criterion is clear; the second requires discussion.

Consider first an attribute that is needed to perform semantic analysis. As an implementation is building a DIANA structure, it is free to create extra (non-DIANA) attributes for its purposes. Thus the desired attributes can be created by those implementations that need them. To require these attributes to be represented by all DIANA users is an imposition on implementations which use algorithms that do not require these particular attributes.

Consider now an attribute needed to perform code generation. As long as the attribute can be determined in a single pass, the routine that reads in the DIANA can readily add it as it reads in the DIANA. Again, some implementors may not need the attribute, and it is inappropriate to burden all users with it.

It is for these reasons that suggestions for pointers to the enclosing compilation unit, pointers to the enclosing namespace, and back pointers in general have been rejected. These are attributes that are easily computed in one pass through the DIANA tree and indeed may not be needed by all implementations.

Of course, a DIANA producer can create a structure with extra attributes beyond those specified for DIANA. Nevertheless, any DIANA consumer that relies on these additional attributes is not a DIANA "user", as defined in this document.

4.1.3 REGULARITY OF DESCRIPTION

In order to increase the clarity of the DIANA description, it was decided that the class structure of DIANA should be a hierarchy. Unfortunately, some nodes should belong in more than one class. To circumvent this problem, several intermediate nodes were defined, nodes for which the only non-lexical attribute denotes a node that already belongs to another class. These intermediate nodes do not convey any structural or semantic information beyond the value of the non-lexical attribute. DIANA contains the following intermediate nodes:

block_master

discrete_subtype
integer_def
float_def
fixed_def
choice_exp
choice_range
stm_pragma
select_alt_pragma
alternative_pragma
comp_rep_pragma
context_pragma
variant_pragma

It should be noted that not all nodes containing a single non-lexical attribute are intermediate nodes. For instance, the renames_unit node has a single non-lexical attribute as name; however, the renames_unit node is not an intermediate node because it is used to convey the fact that a unit has been renamed, in addition to recording the name of the original unit via the as name attribute. On the other hand, the choice_exp node was introduced merely because the class EXP could not be included in both ASSOC and CHOICE. It contains no more information than the EXP node denoted by its as exp attribute.

It is not the intention of DIANA to require that intermediate nodes be represented as such; they are included in the definition of DIANA only to maintain a hierarchy. This is a natural place for an implementation to optimize its internal representation by excluding the intermediate nodes, and directly referencing each node denoted by the non-lexical attribute of an intermediate node.

In the DIANA description, attributes are defined at the highest possible level; i.e. if all of the nodes of a class have the same attribute then the attribute is defined on the class rather than on the individual nodes. In this way a node may "inherit" attributes from the class to which it belongs, and from the class to which that class belongs, etc.

The node void receives a slightly different treatment than the other DIANA nodes. It is the only node which violates the DIANA hierarchy, and it is the only node which inherits attributes which cannot be used. The node void represents "nothing". It may be thought of as a null pointer, although it does not have to be represented as such. Instead of requiring a different kind of void node for each class to which void belongs, void was allowed to belong to more than one class (thus constituting the only exception to the hierarchy). Because void is a member of many classes, it inherits numerous attributes. Rather than move the attribute definitions from the classes and put them on all of the constituent nodes except for void, it was decided to allow void to inherit attributes. Since it is meaningless for "nothing" to have attributes, a restriction was added to the semantic specification of DIANA. The attributes of void may not be manipulated in any way; they cannot be set or examined, hence they are in effect not represented in a DIANA structure.

Section 4.2

DECLARATIONS

4.2 DECLARATIONS

Explicit declarations are represented in a DIANA structure by declarative nodes. These nodes preserve the source text for source reconstruction and conformance checking purposes. They do not record the results of semantic analysis; that information is contained in the corresponding defining occurrence nodes. All declarative nodes have a child that is a node or sequence of nodes (of type SOURCE_NAME) representing the identifier(s) used to name the newly defined entity or entities.

Declarative nodes are members of class ITEM. The nodes in class ITEM are grouped according to similarities in the syntax of the code that they represent and similarities in the context in which they can appear.

4.2.1 MULTIPLE ENTITY DECLARATIONS

Certain kinds of declarations -- object declarations, number declarations, discriminant declarations, component declarations, parameter declarations, and exception declarations -- can introduce more than one entity. The nodes corresponding to these declarations belong to two different classes, DISCRMT_PARAM_DECL and ID_S_DECL, both of which define an as source name s attribute. These classes are distinguished from each other because they appear in different contexts. Discriminant declarations can appear only in discriminant parts, and parameter declarations can appear only in formal parts. The remaining multiple entity declarations are basic declarative items, and can appear in declarative parts. In addition, the basic declarative items can appear in sequences containing pragmas, which cannot be given in discriminant parts or formal parts.

ID_S_DECL is further subdivided into classes according to the syntactic similarities of the declarations it represents. For instance, object declarations and number declarations may have (default) initial values, hence constant_decl, variable_decl, and number_decl belong to class EXP_DECL, which defines an as exp attribute to record that value.

4.2.1.1 OBJECT DECLARATIONS AND COMPONENT DECLARATIONS

The type portion of object declarations may be given in two different ways: either by a subtype indication or a constrained array definition. The node

constrained_array_def is already a member of class TYPE_DEF, which represents the syntax of type definitions. Rather than include constrained_array_def in another class and disrupt the hierarchy, the node subtype_indication was added to class TYPE_DEF. Thus the class OBJECT_DECL, which comprises the nodes constant_decl and variable_decl, defines the attribute as_type_def to represent the type specification given in the object declaration. Obviously as_type_def cannot denote any kind of TYPE_DEF node other than subtype_indication and constrained_array_def in this particular context.

The only other kind of declaration which introduces objects and does not require the type specification to be a type mark is a component declaration, the type portion of which is given by a subtype indication. Rather than define a node exclusively for component declarations, they are represented by the same kind of node as variable declarations, since the variable_decl node allows subtype indications for the as_type_def attribute. This is also convenient because component declarations may be interspersed with pragmas, and both pragma and variable_decl belong to class DECL (a sequence of component declarations is represented by a decls sequence). Component declarations and variable declarations may be distinguished by the fact that they appear in different contexts, and by the type of nodes in the as_source_name_s sequence. The former contains component_id nodes and the latter contains variable_id nodes.

A record component list may contain the reserved word "NULL" rather than component declarations or a variant part. This is indicated by the insertion of a null_comp_decl node instead of variable_decl nodes in the sequence of component declarations. Hence it was necessary to include the null_comp_decl node in class DECL. It is convenient for the null_comp_decl node to be part of a sequence because it may be followed by pragmas (a pragma can appear after a semicolon delimiter). Although null_comp_decl belongs to DECL, the ONLY place that it can appear in a DIANA structure is as the first node in the as_decl_s sequence of the comp_list node (this restriction is given in the semantic specification of DIANA).

4.2.2 SINGLE ENTITY DECLARATIONS

The remaining kinds of declarations introduce single entities. They are represented by the classes SUBUNIT_BODY and ID_DECL. Like the classes DSCRMT_PARAM_DECL and ID_S_DECL, SUBUNIT_BODY and ID_DECL are distinguished because they represent declarative items which occur in different contexts. SUBUNIT_BODY represents body declarations, both proper body and stub declarations. These declarations are separated from the declarations in ID_DECL because body declarations are exclusively later declarative items (the few members of ID_DECL that are later declarative items are basic declarative items as well). ID_DECL contains basic declarative items and items that can appear in task specifications.

Body declarations include subprogram body declarations, package body declarations, task body declarations, and stub declarations. These declarations are represented by the nodes subprogram_body, package_body, and task_body. The difference between a proper body and a stub is indicated by the value of the as_body attribute, a block_body in the former case, and a stub in the latter.

4.2.2.1 PROGRAM UNIT DECLARATIONS AND ENTRY DECLARATIONS

Due to syntactic similarities, declarations of entries and program units other than tasks are represented by nodes from class UNIT_DECL, which contains only three members: generic_decl, subprog_entry_decl, and package_decl. The combination of the kind of node representing the declaration and the values of the as_header and as_unit_kind attributes uniquely determine the exact form of the declaration. The different kinds of declarations are listed with their appropriate attribute values in Table 4.1.

The HEADER and UNIT_KIND nodes also record information peculiar to that sort of declaration. For example, the renames_unit node not only indicates that a declaration is a renaming declaration, but retains the name of the original unit as well.

A task declaration can introduce either a task type, or a single task object with an anonymous type, depending on whether or not the declaration contains the reserved word "type". The syntax of a task declaration differs from that of an ordinary type or object declaration, hence the type_decl and variable_decl nodes are not suitable for representing a task declaration. Because the same information is given in the task declaration regardless of the kind of entity it introduces, a task_decl node represents both kinds of task declarations. If the defining occurrence associated with the declaration is a variable_id then the declaration creates both an object and a type; if the defining occurrence is a type_id then the declaration creates a type.

Since a task declaration always defines a new task type, a new task type specification (a task node) is created for each declaration. If the type is anonymous it is introduced by the sm_obj_type attribute of the variable_id; otherwise the task node is introduced by the sm_type_spec attribute of the type_id.

It should be noted that a task object may also be declared with an ordinary object declaration. Since declarative nodes record the syntax of the declaration, a variable_decl node rather than a task_decl node denotes the declaration in this case. This kind of declaration does not introduce a new task type, thus a new task type specification is not created for the task object(s).

declaration, at which point the context indicates whether or not the declaration and its defining occurrence(s) are generic.

4.2.5 IMPLICIT DECLARATIONS

The Ada programming language defines different kinds of implicit declarations. Certain operations are implicitly declared after a type definition (including derived subprograms following a derived type definition). Labels, loop names, and block names are implicitly declared at the end of the corresponding declarative part. These declarations are not explicitly represented in DIANA; to do so would interfere with source reconstruction.

Since a label, loop name, or block name can be associated with only one statement, and the label or name precedes that statement in the source text, it is natural for the defining occurrence of a label (a `label_id`) to be its appearance in a labeled statement, and the defining occurrence of a block or loop name (a `block_loop_id`) to be its appearance in a block or loop statement.

Implicitly declared operations and derived subprograms are associated with a single type definition. Unfortunately, the names of these operations and derived subprograms are not used in that type definition. As a result, there is no appropriate structural attribute to introduce the defining occurrences of the operations associated with a type. All appearances of the names of these operations and derived subprograms are represented in the DIANA structure as used occurrences. A defining occurrence still exists for each such operation or derived subprogram; however, it can only be referenced by semantic attributes.

Section 4.3

SIMPLE NAMES

4.3 SIMPLE NAMES

Simple names comprise identifiers, character literals, and operator symbols.

The attributes lx srcpos and lx comments are defined for all DIANA nodes that represent source code. An implementation has the option of including these attributes or not; however, if an implementation does choose to include them then it is necessary to have a distinct node for every occurrence of a simple name in the source code. Since it is not desirable to have to copy all of the semantic attributes associated with the name of an entity every time the name is used, the appearances of simple names in a DIANA tree are divided into defining and used occurrences. The former are represented by class DEF_NAME and the latter by class DESIGNATOR.

In order to avoid constraining an implementation, DIANA does not REQUIRE that a distinct used occurrence node be created for every use of a simple name. A single used occurrence node may be created for a particular name, and all references to that entity in the source code may be represented by references to that single used occurrence node in the DIANA structure.

The defining nodes for entities together with their attributes play the same role as a dictionary or symbol table in conventional compiler strategy. Unless there is interference from separate compilation, it is possible for all information about an entity to be specified by attributes on its defining node. The node for a used occurrence of an entity always refers back to this defining occurrence via the sm defn attribute.

Defining occurrences are represented by different kinds of nodes rather than a single construct, thereby allowing the appropriate semantic attributes to be attached to each. For instance, the defining occurrence of a discriminant is represented by a discriminant_id, which has an attribute to record the applicable component clause (if there is one); the defining occurrence of a constant is represented by a constant_id, which has an attribute that references the applicable address clause (if there is one).

DIANA also distinguishes the kinds of usage depending on the properties of the entity that is referenced. For example, a used occurrence of an object name is represented by a used_object_id, while that of an operator is represented by a used_op.

DIANA has the following set of defining occurrences.

- attribute_id
- argument_id
- block_loop_id
- bltn_operator_id
- character_id
- component_id
- constant_id
- discriminant_id
- entry_id
- enumeration_id
- exception_id
- function_id
- generic_id
- iteration_id
- in_id
- in_out_id
- label_id
- l_private_type_id
- number_id
- operator_id
- out_id
- package_id
- pragma_id
- private_type_id
- procedure_id
- subtype_id
- task_body_id
- type_id
- variable_id

and the following set of used occurrences:

- used_char
- used_name_id
- used_object_id
- used_op

4.3.1 DEFINING OCCURRENCES OF PREDEFINED ENTITIES

The consistency of this scheme requires the provision of a definition point for predefined identifiers as well. Although these nodes will never be introduced by a structural attribute because they do not have an explicit declaration, they can be referenced by the sm defn attribute of a node corresponding to a used occurrence.

Certain kinds of entities, such as exceptions, may be either predefined or user-defined. Such an entity is represented by the same kind of node in either case -- a node from class SOURCE_NAME, which represents the defining occurrences of all entities which can be declared by the user. If, however, a SOURCE_NAME node corresponds to a predefined entity then the lx srcpos and lx comments

attributes will be undefined since it does not correspond to source text.

Other entities can never be declared by the user; i.e. pragmas, pragma argument identifiers, and attributes. These entities are represented by nodes from class PREDEF_NAME; the lx srcpos and lx comments attributes of nodes belonging to this class are never defined. PREDEF_NAME also contains nodes corresponding to defining occurrences of the predefined operators (these operators cannot be declared by the user, although they may be overloaded). A user-defined operator is represented by a node from class SOURCE_NAME.

4.3.2 MULTIPLE DEFINING OCCURRENCES

In general, every entity has a single defining occurrence. In the instances where multiple defining occurrences can occur, each defining occurrence is represented by a DEF_NAME node.

The entities which may have multiple defining occurrences are:

- (a) deferred constants
- (b) incomplete types
- (c) non-generic (limited) private types
- (d) discriminants of incomplete or (limited) private types
- (e) non-generic formal parameters
- (f) program units

With the exception of tasks and (limited) private types, the different defining occurrences of one of these entities are represented by the same kind of node. In addition, the different defining occurrences have the same attribute values (certain incomplete types and program units may have attributes which cannot be set in the first defining occurrence due to interference by separate compilation; however, this is an exception rather than a rule). These defining occurrences have an attribute, sm first, that refers to the node for the first defining occurrence of the identifier, similar to the sm defn attribute of used occurrences. The node that is the first defining occurrence has an sm first attribute that references itself.

All used occurrences must reference the same defining occurrence, the one that occurs first. Nevertheless, the attributes for all defining occurrences of an entity must still be set with the appropriate values.

An entry declaration and its corresponding accept statement are not treated as different definition points of the same entity. Thus the entry_id is the unique defining occurrence; a used_name_id appears in an accept statement, the sm defn attribute of which refers to the associated entry_id. However, the formal parts of the entry declaration and the accept statement multiply define the entry formal parameters.

Any names appearing in a record representation clause or an enumeration representation clause are considered used occurrences; this includes the names of record types, record components, and enumeration literals.

4.3.2.1 MULTIPLE DEFINING OCCURRENCES OF TYPE NAMES

There are two forms of type declaration in which information about the type is given at two different places: incomplete and private. In addition to the multiple defining occurrences of the type names there are multiple defining occurrences of the discriminant names if the types include discriminant parts.

The notion of an incomplete type permits the definition of mutually dependent types. Only the new name is introduced at the point of the incomplete type declaration -- the structure of the type is given in a second type declaration which generally must appear in the same declarative part. The defining occurrences of both types are described by type_id nodes which have the semantic attribute sm type spec. With one exception (which is discussed in the following paragraph) the full type declaration must occur in the same declarative part, hence the sm type spec attribute of both defining occurrences can denote the full type specification.

A special case may be introduced when an incomplete type declaration occurs within the private part of a package specification. The full type declaration is not required to appear in the same declarative part; it may be given in the declarative part of the package body, which is not necessarily in the same compilation unit. Since forward references are not allowed in DIANA, if the full type declaration is in a separate compilation unit then the sm type spec attribute of the type_id corresponding to the incomplete type declaration denotes a special incomplete node (which is discussed in detail in the section on types). The sm type spec attribute of the node for the full type declaration references the full type specification.

Private types are used to hide information from the user of a package; a private type declaration appears in the visible part of a package without any structural information. The full declaration is given in the private part of the package specification (this restriction ensures that there is no interference from separate compilation). Unfortunately, the solution used for incomplete types cannot be applied to private types -- if both defining occurrences had the same node type and attributes, it could not be determined whether the type is a private one or not. This information is important when the type is used outside of the package.

DIANA views the declarations as though they were declarations of different entities -- one is a private type and the other a normal one. Both denote the same type structure in their sm type spec attribute, however. The distinction is achieved by introducing a new kind of a defining occurrence, namely the private_type_id. It has the attribute sm type spec which provides access to the structural information given in the full type declaration. Limited private types are treated in the same manner, except that their defining occurrence is a l_private_type_id. In the case of (limited) private types the sm first attribute of the type_id node refers to the private_type_id or l_private_type_id. The private_type_id and l_private_type_id nodes do not have

an sm first attribute because they always represent the first defining occurrence of the type name.

4.3.2.2 MULTIPLE DEFINING OCCURRENCES OF TASK NAMES

The only other entity to have its different defining occurrences represented by different kinds of nodes is the task. Although a task is a program unit, its defining occurrences cannot be treated like those of other program units. The declaration of a task introduces either a task type or a task object having an anonymous type, hence the first defining occurrence of a task name is represented by a type id or a variable id. Any subsequent defining occurrences of the task name must correspond to either a stub declaration or a proper body declaration; these defining occurrences are represented by task_body_id nodes.

All of the information concerning the task is stored in the type specification of the task. Even though used occurrences of the task name do not reference the type specification (they denote the type id or variable id), the type specification may be reached from any of the defining occurrences.

4.3.3 USED OCCURRENCES

The nodes representing used occurrences are included in the class representing expressions because certain names may appear in expressions. Restrictions have been added to the semantic specification to differentiate the used occurrences which can appear in expressions from those which cannot.

The nodes used_object_id and used_char represent used occurrences of entities having a value and a type; these nodes can appear in the context of an expression. The former denotes objects and enumeration literals, the latter denotes character literals (in this way identifiers consisting of a single character are distinguished from character literals). To allow the nodes representing expressions to be treated in a consistent manner, the attributes sm value and sm exp type were added to the used_object_id and used_char nodes.

The remaining kinds of used occurrences are represented by the used_op and used_name_id nodes. The occurrence of an operator is represented by a used_op, and that of any other entity by a used_name_id.

The names of objects and literals may appear in contexts other than expressions; in particular, in places where the Ada syntax requires a name. Should those used occurrences be represented by used_object_id nodes or used_name_id nodes? In some instances it might be useful to have ready access to more information than just the name (for example, the subtype of the object denoted by the name might be helpful). Some names (such as the "object_name" in a renaming declaration) must be evaluated just as an expression is evaluated. On the other hand, a name appearing in the left-hand part of a named association is not evaluated, and since the association is not designed for semantic processing (a normalized list of expressions is created for that purpose), it would be wasteful to record additional semantic attributes.

It was decided that the name of an object or literal appearing in the left-hand part of a named association should be represented by a used_name_id because the attributes peculiar to a used_object_id would not be needed for semantic processing in that context. Since the situation is not as clear in other contexts, all other uses of the name of an object or literal are represented by used_object_id nodes.

- (b) anonymous base types created by constrained array definitions [ARM, 3.6]
- (c) anonymous index subtypes created by constrained array definitions [ARM, 3.6]
- (d) anonymous task types introduced by task declarations creating single task objects [ARM, 9.1]

The declarations of these anonymous types are not represented (to do so would interfere with source reconstruction), hence their type specifications are introduced by the appropriate semantic attributes. For instance, the node for an anonymous task type is introduced by the sm obj type attribute of a variable_id node. At some point it will be necessary to know that such types are anonymous (i.e. that they have not yet been elaborated), consequently the sm is anonymous attribute was added to all nodes except for those representing universal types (which are always anonymous).

In order to maintain the consistency of this type representation scheme it was necessary to include some anonymous types and subtypes which are not discussed in the reference manual.

Type definitions containing subtype indications with explicit constraints introduce anonymous subtypes. Hence the component subtype of an array or the designated subtype of an access type may be anonymous. If the constraints on the parent type and the parent subtype of a derived type are not the same then the new base type is anonymous.

Every object and expression in DIANA has an attribute denoting its subtype (sm obj type for objects and sm exp type for expressions). The subtype specification contains the applicable constraint (necessary for operations such as constraint checking) as well as a path to the base type (which is required for processing such as type resolution). If a new constraint is imposed by an object declaration or an expression then an anonymous type specification must be created in order to record the new constraint. Object or component declarations containing either a constrained array definition or a subtype indication with an explicit constraint introduce anonymous subtypes for each entity in the identifier list. Slices, aggregates, and string literals introduce anonymous subtypes if it cannot be determined statically that the constraints on the expression and those on the array prefix or context subtype are the same.

Unlike class TYPE_DEF, which is subdivided according to syntactic similarities, class TYPE_SPEC is decomposed into subclasses by the semantic characteristics (i.e. attributes) various members have in common. When placing the nodes in the hierarchy, certain compromises were made that cause a few nodes to inherit an attribute that is not really needed. For instance, the constrained_array and constrained_record nodes inherit the attribute sm derived, even though they can never represent a derived type (they may, however, represent a subtype of a derived type). It was deemed better to have an occasional unneeded attribute than to cause confusion by defining common attributes in several different places (i.e. moving the constrained_array and constrained_record nodes outside of class DERIVABLE_SPEC and duplicating the attributes sm is anonymous, sm base type, and sm depends on dscrmt for them).

4.4.1 CONSTRAINED AND UNCONSTRAINED TYPES AND SUBTYPES

A TYPE_SPEC node provides no indication as to whether the entity it represents is a type or a subtype. In the Ada language, the name of a type denotes not only the type, but the corresponding unconstrained subtype as well. An attempt at differentiating types and subtypes would only cause confusion and inconsistencies. A distinction is made, however, between base types and subtypes of base types. The attribute sm base type denotes the base type, a type specification where all representation and structural information can be found. Obviously the sm base type attribute of a node corresponding to a base type will contain a self-reference.

Certain nodes always represent base types; these are the task spec node, and those in classes PRIVATE_SPEC and UNCONSTRAINED_COMPOSITE. The task spec and PRIVATE_SPEC nodes do not have an sm base type attribute at all. As a result of their inclusion in class NON_TASK the UNCONSTRAINED_COMPOSITE nodes have inherited this attribute; however, it always contains a self-reference.

DIANA also distinguishes between constrained and unconstrained (sub)types for the following classes of types: array, record, and access. The nodes in class UNCONSTRAINED represent unconstrained types; those in class CONSTRAINED represent constrained types.

This distinction proves to be very useful when performing certain semantic checks involving array, record, or access types. For instance, the types in these classes may have index or discriminant constraints imposed upon them; however, an index or discriminant constraint cannot be imposed on the type if it is already constrained.

The fact that an object is of an unconstrained type rather than a constrained type may also affect certain implementation decisions. For example, in a complete assignment to a record object of an unconstrained type that has default values for its discriminants, the constraints on the object may be changed during execution. Hence an implementation may wish to handle objects of an unconstrained record type in a manner that is different from the way in which objects of a constrained type are treated.

All scalar types are constrained, and may be further constrained any number of times. Hence there is only one kind of node for each kind of scalar type, and each SCALAR node has an sm range attribute which denotes the applicable range constraint. The nodes for real types have an additional sm accuracy attribute to record the value of the digits or delta expression. For some types (such as the predefined types and enumeration types) the constraints are implicit, therefore a range node which does not correspond to source code must be created. The range node that is constructed for an enumeration type will denote the first enumeration literal as the lower bound and the last enumeration literal as the upper bound. The range node for a predefined numeric type will have for its bounds expressions (determined by the implementation) which do not correspond to source code.

Constraints cannot be applied to a task type, therefore the question of whether or not it is constrained is irrelevant.

Section 4.4

TYPES AND SUBTYPES

4.4 TYPES AND SUBTYPES

In the Ada language certain types and subtypes may be declared in more than one way. For instance, the following sets of declarations produce equivalent subtypes:

```
type CONSTRAINED_AR is array (INTEGER range 1 .. 10) of BOOLEAN;
```

```
type INDEX is INTEGER range 1 .. 10;
```

```
type UNCONSTRAINED_AR is array (INDEX range <>) of BOOLEAN;
```

```
subtype CONSTRAINED_AR is UNCONSTRAINED_AR (INDEX);
```

the only difference being that the base type and index subtype corresponding to the first declaration are anonymous. In order to reconstruct the source text it is necessary that the syntax of the declarations be recorded; however, semantic processing would be facilitated if the same representation were used for CONSTRAINED_AR regardless of which set of declarations produced it. In order to satisfy both needs DIANA has two classes associated with types and subtypes.

The class TYPE_DEF records syntax. The nodes belonging to this class are not intended to be used for semantic processing, hence they have no semantic attributes, and are never designated by any kind of attribute other than a structural attribute. A TYPE_DEF node may correspond to:

- (a) a subtype indication
- (b) the portion of a type declaration following the reserved word "is"
- (c) the type of an object as given in an object declaration

TYPE_DEF is subdivided into classes according to syntactic similarities of the source text which the nodes represent. The class structure of TYPE_DEF has no semantic meaning.

TYPE_DEF contains three nodes which are really intermediate nodes: integer_def, float_def, and fixed_def. The syntax of a numeric type definition consists solely of a range, floating point, or fixed point constraint. Unfortunately, the nodes representing these constraints are already members of class CONSTRAINT -- to include them in TYPE_DEF as well would have introduced multiple class memberships. Instead, three new nodes were introduced into

TYPE_DEF; each has a single structural attribute denoting the actual constraint.

Class **TYPE_SPEC** is the complement of **TYPE_DEF**; it represents the Ada concept of types and subtypes. The nodes comprising **TYPE_SPEC** are compact representations of types and subtypes, suitable for semantic processing. It is not necessary to traverse a lengthy chain of nodes in order to obtain all of the pertinent information concerning the type/subtype, nor are special cases (i.e. different structures) introduced by irrelevant syntactic differences. The nodes comprising class **TYPE_SPEC** do not record source text; they contain semantic attributes only, and are not accessible through structural attributes.

Because the **TYPE_SPEC** nodes are not designed to record source code, but are intended to represent the concept of types and subtypes, there is not necessarily a one-to-one correspondence between the types and subtypes declared in the source and the **TYPE_SPEC** nodes included in the DIANA tree. An implementation must represent each of the universal types (which cannot be explicitly declared in an Ada program), and additional nodes may be created to represent various anonymous types (to be described later). Consequently, it is not possible to store the type specification information within the nodes denoting defining occurrences of types and subtypes. Thus the **type_id** and **subtype_id** nodes of class **DEF_NAME** represent the NAMES of types and subtypes, not the types and subtypes themselves. Access to the corresponding type specification is provided by means of the sm_type_spec attribute.

The construction of new **TYPE_SPEC** nodes for a DIANA tree is governed by two basic principles:

1. Each distinct type or subtype is represented by a distinct node from class **TYPE_SPEC**.
2. There are never two **TYPE_SPEC** nodes for the same type or subtype

These principles ensure that the only action needed to determine whether or not two entities have the same subtype or the same base type is the comparison of the associated **TYPE_SPEC** nodes. If both denote the same node (not equivalent nodes, but the SAME node) then the types are the same; if they reference different nodes then the types are not the same.

Since a type definition always creates a new type, a new **TYPE_SPEC** node is created for every type definition. This is not necessarily true for subtype declarations. If a subtype declaration does not include a constraint then it does not introduce a new subtype (it in effect renames the subtype denoted by the type mark), therefore a new **TYPE_SPEC** node is not introduced. In this case the sm_type_spec attribute of the **subtype_id** denotes the **TYPE_SPEC** node associated with the type mark.

All anonymous types described in the Ada Reference Manual are represented in DIANA; i.e.

- (a) anonymous derived types created by numeric type definitions [ARM, sections 3.5.4, 3.5.7, and 3.5.9]

The nodes representing constrained types have an additional attribute, sm depends on dscrmt, which indicates whether or not the component subtype depends on a discriminant. A subtype of a record component depends on a discriminant if it has a constraint which contains a reference to a discriminant of the enclosing record type. Within a record type definition, the only forms of constraints which can contain a reference to a discriminant are index and discriminant constraints. Since the only nodes for which this attribute could ever be true are the constrained_array, constrained_record, and constrained_access nodes, it was not necessary to define an sm depends on dscrmt attribute for any other TYPE_SPEC nodes (although a component subtype may be a private type with a discriminant constraint, such a subtype is represented by a constrained_record node rather than a PRIVATE_SPEC node, as discussed in section 4.4.4).

The sm depends on dscrmt attribute was defined because otherwise it would not be easy to determine whether or not a component subtype depended on a discriminant if the constraint were sufficiently complicated. This information is essential because at certain times a component subtype that depends on a discriminant is treated differently from one that does not. For instance, the elaboration time of a component subtype is determined by whether or not it depends on a discriminant. If the component subtype does not depend on a discriminant then it is elaborated when the enclosing record type is elaborated; otherwise the component subtype is not fully elaborated until a discriminant constraint is imposed on the enclosing record type (the expressions in the component subtype indication which are not discriminants are evaluated during the elaboration of the enclosing record type).

4.4.2 UNIVERSAL TYPES

The Ada programming language defines three universal types -- universal integer, universal real, and universal fixed. The TYPE_SPEC nodes for the universal types have no attributes of their own since their properties are fixed -- they are not implementation dependent, nor can they be declared by a user. For example, there is no need for the sm is anonymous attribute because universal types are always anonymous. The universal types are used as the types of named numbers and certain static expressions.

4.4.3 DERIVED TYPES

All types other than the universal types may be derived, although restrictions may be placed on the location of certain kinds of derived type definitions. For instance, a derived type definition involving a private type is not allowed within the package specification declaring that private type [ARM, 7.4.1]; however, that private type may be derived outside of the package specification. Hence the attribute sm derived is defined for class DERIVABLE_SPEC. If a type is derived then sm derived references the TYPE_SPEC node of the parent type (not the parent subtype); otherwise the attribute is void.

A derived type definition creates a new base type whose properties are derived from the parent type. In addition, it defines a subtype of the derived type. A derived type definition in DIANA always results in the creation of a new TYPE_SPEC node for the new base type. Since its characteristics are derived from the parent type it will need the same kinds of attributes in order to represent the appropriate values, thus the base type is represented by the same kind of node as the parent type.

If the parent type and the parent subtype of a derived type do not have the same constraints, then a new TYPE_SPEC node is created for the subtype of the derived type. This node will record the new constraint, and its base type will be the newly created base type. The name of the derived type will denote this subtype, hence all references to the derived type will denote the type specification of the subtype. As a result, the base type is anonymous.

If the base type is a record or enumeration type then a representation clause may be given for the derived type if a representation clause was not given for the parent type BEFORE the derived type definition. Hence it is possible for the derived type to have a different representation from that of the parent type. The information given in an enumeration representation clause is recorded in the nodes for the literals of the enumeration type; the information from the component clauses is encoded in the nodes for the components (including discriminants) of the record type. Due to the possibility of different representations, it is not always feasible for the derived type to share the enumeration literals or record components of the parent type.

DIANA requires that copies be made of the defining occurrences of the enumeration literals, unless the parent type is a generic formal discrete type, which does not have any literals. The new literals reference the derived type as the type to which they belong, but have the same position number as the corresponding original literals. If a representation clause is not given for the derived type then the sm_rep attribute will also have the same value. The node for the derived type denotes these new defining occurrences as its literals. Duplication has an additional advantage for enumeration literals -- since the literal of the derived type overloads the corresponding literal of the parent type, it is convenient to have two different defining occurrences when processing used occurrences of the literals.

DIANA also requires the duplication of the discriminant part and the component list for a derived record type if a representation clause is given for that type. If an implementation determines that no such clause is given, it can choose whether to copy the defining occurrences or reference the structure of the parent type. Because the defining occurrences do not reference the record type to which they belong, no inconsistencies are introduced if the structure is not copied when the representation does not change.

4.4.4 PRIVATE, LIMITED PRIVATE, AND LIMITED TYPES

A private type declaration separates the properties of the type that may be used outside of the package from those which are hidden from the user. A private type has two points of declaration -- the first declaration is the private one, occurring in the visible part of the package specification; the

second is a full type declaration that appears in the private part of the package. Private and limited private types are represented by nodes from `PRIVATE_SPEC`, and complete type specifications by those belonging to `FULL_TYPE_SPEC`.

A (limited) private declaration introduces a `private` or `l_private` node, and the subsequent full type declaration introduces the appropriate node from class `FULL_TYPE_SPEC`. The (limited) private specification rather than the full type specification is referenced as the type of an object, expression, etc. In addition, all used occurrences of the type name will denote the `type_id` of the private declaration. The `PRIVATE_SPEC` nodes have an `sm_type_spec` attribute that provides access to the full type specification. In this way the distinction between private and full types is preserved for the kinds of semantic processing which require knowledge of whether or not a type is private, but the information recorded in the full type specification is available for the processing which needs it.

The specification of a (limited) private type may be viewed as being distributed over two nodes, rather than being represented by two different nodes. The full type specification can never be referenced as the type of an object, expression, etc., hence the principle that there are never two `TYPE_SPEC` nodes for the same type or subtype is not violated by this representation of (limited) private types.

An alternate solution was considered. It was proposed that all references to the (limited) private type occurring either outside of the package or within the visible part of the package denote the `PRIVATE_SPEC` node, and those references occurring within either the private part of the package or the package body denote the `FULL_TYPE_SPEC` node. Although there would be two `TYPE_SPEC` nodes for one type, within a given area (the two areas being the one in which the type structure is hidden and the one in which the type structure is visible) it would appear as if there were only one node. With this approach the uses of the type would reflect whether or not the structure of the type was visible at that point in the source code. Unfortunately, upon closer examination the previous assumptions proved to be untrue.

Consider the case of a subprogram declared in the visible part of a package. Suppose the subprogram has a parameter of a private type that is declared in the visible part of the same package. Although it is possible for the parameter in the subprogram declaration to denote the private specification as its type, and the parameter in the subprogram body declaration to denote the full type specification as its type, ALL references to both the subprogram and its parameters denote the first defining occurrences -- those in the package specification, which reference the private specification. Suppose an object of the private type were declared inside the subprogram body; it would refer to the full type specification as its type. The subprogram body would then contain a mixture of references to the private type -- some to the full type specification, others to the private specification. It would no longer be possible to simply compare `TYPE_SPEC` nodes to determine if two entities have the same type. As a consequence, this solution was rejected.

The `private` and `l_private` nodes always represent base types. Although a subtype of a (limited) private type may be introduced, it will be represented by a node from class `FULL_TYPE_SPEC` rather than one from `PRIVATE_SPEC`. Due to the

restrictions placed on the creation of new `TYPE_SPEC` nodes, a new node may be created for such a subtype only if a new constraint is imposed upon it (in other words, the subtype is not a renaming of another type or subtype).

The kinds of constraints which may be imposed upon a (limited) private type are restricted in those regions where the full structure of the type is hidden. The structure (and therefore the class) of a private or limited private type without discriminants is not visible outside of the package or in the visible part of the package, therefore no new constraints may be imposed on such types in these regions. If a private type has discriminants then its full type must be a record type, and a discriminant constraint is permitted even in the locations where the structure of the rest of the record is unknown. That subtype is represented by a `constrained_record` node. If the declaration occurs within the private part of the package or the package body then the structure of the private type is visible, and the subtype is represented by the appropriate node from class `FULL_TYPE_SPEC`.

The `l_private` node represents types which are limited private, not types which are limited. Types which are limited include task types, composite types having a subcomponent which is limited, and types derived from a limited type. Because these types are not explicitly declared to be limited, they are not represented by a distinct node kind as the limited private types are (to do so would require semantic analysis to determine when the distinct node kind was appropriate). Instead, an additional attribute is defined where necessary.

Task types are always limited, hence there is no need to record that information in the form of an additional attribute. This is not true for arrays and records. Determining whether or not an array or record has any limited subcomponents could be a very time-consuming process if the structure of the composite type is very complicated. As a consequence, the `sm is limited` attribute was defined for the class `UNCONSTRAINED_COMPOSITE`. It has a boolean value indicating whether or not the type is limited. Since derived types are represented by the same kind of nodes as their parent types, the fact that a derived type is limited can be recorded in same way that it was recorded for the parent type.

On the surface it may seem that a problem similar to that discussed for composite types having limited components exists for composite types having private components. A composite type that has private subcomponents and is declared outside of the package containing the private type definition has certain restrictions placed on the operations allowed for the composite type. The only operations permitted are those which are dependent on the characteristics of the private declaration alone (see section 7.4.2 of the Ada Reference Manual).

A closer examination reveals that at most it is necessary to check a component type (as opposed to component types and subcomponent types) to determine if an operation is legal or not. The operations allowed for types which are composites of composites are also allowed for composite types with private components (assignment, aggregates, catenation, etc.). Operations involving the private component rather than the composite type as a whole may be restricted; for instance, a selected component involving a component of the private component is not allowed. Since the type of the private component is determined during type resolution of the sub-expression, no lengthy searches are

required to determine that the component is private. Certain operations that are allowed for arrays of non-composite objects, such as the relational operators for arrays of scalar components and the logical operators for arrays of boolean components, would not be allowed under the circumstances described above because it would not be possible to determine if the component type were indeed a scalar type or a boolean type. However, such a check involves only a single component type.

A need could not be found for an attribute indicating that an array or record has private subcomponents; hence none was defined.

4.4.5 INCOMPLETE TYPES

An incomplete type definition allows the definition of "mutually dependent and recursive access types" [ARM, 3.8.1]. Like a private type, it has two points of definition: one for the incomplete type, and a second for the full type specification.

Although the uses of the name of an incomplete type are restricted when they occur before the end of the subsequent full type declaration (the name may appear only in the subtype indication of an access type definition), the incomplete type becomes an ordinary full type once its structure has been given. Since there is no need to distinguish the incomplete type from a full type once the structure of the full type is known, the solution adopted for private types is not appropriate for incomplete types. In general, incomplete types are not represented as such in DIANA; their full type specifications are represented by nodes from class FULL_TYPE_SPEC, and attributes denoting the incomplete type actually reference the full type specification.

Only one sort of incomplete type is represented by a distinct node in the DIANA tree. Included in the class TYPE_SPEC is the node `incomplete`, which was introduced to handle an anomaly in the Ada programming language. The language places the following restrictions on the placement of the full type declaration:

"If the incomplete type declaration occurs immediately within either a declarative part or the visible part of a package specification, then the full type declaration must occur later and immediately within the same declarative part or visible part. If the incomplete type declaration occurs immediately within the private part of a package, then the full type declaration must occur later and immediately within either the private part itself, or the declarative part of the corresponding package body." [ARM, 3.8.1]

Because a package body may be in a separate compilation unit, it is possible for the full type specification of an incomplete type declared in the private part of a package to be in a separate compilation unit. In this case it is not possible for references to the incomplete type which occur in the package specification to denote the full type specification; DIANA forbids forward references of that sort. It was necessary to define a node to represent the incomplete type in this special case, hence the `incomplete` node was introduced. It has a single attribute, `sm discriminant s`, to represent any discriminants belonging to the incomplete type. If the full type specification is not in a different compilation unit the `incomplete` node is not used to represent the

incomplete type.

This problem does not arise for private types. The Ada language requires that the full type specification of a private type be given in the private part of the package specification, thus it may never occur in a separate compilation unit.

DIANA does not specify the manner in which the full type specification may be accessed from the incomplete type specification in this special case -- to do so would impose restrictions on an implementation. All references to the specification of this incomplete type will reference the incomplete node, even those occurring after the full type declaration. Since an implementation must provide some solution to the problem of reaching the full type specification for references to the incomplete type occurring within the package specification, there seemed to be no reason to deviate from the DIANA requirement that all references to a particular entity denote the same node.

It should be noted that it is possible to reach the incomplete type specification from the subsequent full type declaration. The sm first attribute of the type id introduced by the full type declaration denotes the type id of the incomplete type declaration. Both type id nodes have an sm type spec attribute denoting their respective type specifications.

4.4.6 GENERIC FORMAL TYPES

Although "a generic formal type denotes the subtype supplied as the corresponding actual parameter in a generic instantiation" [ARM, 12.1.2], a generic formal type is viewed as being unique within the generic unit. Hence a new TYPE_SPEC node is introduced by each generic type declaration, and the attributes of the node are set as if the generic type were a new type.

A generic formal type is represented by the DERIVABLE SPEC node that is appropriate for its kind. The values of the attributes are set in a manner which reflects the properties of the generic type within the generic unit. For instance, sm base type contains a self-reference, sm derived is void, and sm is anonymous is false, regardless of the whether or not any of the actual subtypes have the same attribute values. A representation specification cannot be given for a generic formal type; this restriction is reflected in the values of all attributes which record representation information (sm size is void, sm is packed is false, etc.).

Some of the attributes of a node representing a generic formal type may be undefined because they require knowledge of the actual subtype. Since there may be numerous instantiations it is not possible to set these attributes in the node representing the generic type. For example, a generic formal discrete type is represented by an enumeration node; the attributes sm literals and sm range are not defined because they depend on the actual subtype. The information recorded by such attributes is not necessary for the semantic processing of the generic type within the generic unit.

The TYPE_SPEC nodes corresponding to generic formal types contain no indication that they are indeed generic formal types. This information can be deduced from the context of the declarations and recorded by an implementation in whatever manner it finds to be most convenient.

4.4.7 REPRESENTATION INFORMATION

Representation specifications can be given for certain types and first named subtypes through pragmas and representation clauses. Although occurrences of these pragmas and representation clauses remain in the DIANA tree to enable the source to be reconstructed, they are additionally recorded with the TYPE_SPEC nodes corresponding to the type structures that they affect.

The occurrences of the language pragmas PACK and CONTROLLED are recorded with the attributes sm is packed (for array and record types) and sm is controlled (for access types).

A representation clause may be given for a record type, giving storage information for the record itself and/or its components; a reference to this specification is recorded in the semantic attributes of the TYPE_SPEC node representing the record type as well as the defining occurrences of the discriminants and components. Similarly for enumeration types, information from representation specifications for the enumeration literals is recorded with the defining occurrences of the enumeration literals.

Length clauses may be applied to various types. The presence of a length clause specifying the storage size for a task or access type is recorded with the sm storage size attribute. A length clause may also be used to place a limit on the number of bits allocated for objects of a particular type or first named subtype. A size specification is indicated by one of two different attributes, depending on the kind of type a particular node represents. The TYPE_SPEC nodes representing non-scalar types have an sm size attribute which is of type EXP; it references the actual expression given in the length clause, and is void if no length clause is given.

TYPE_SPEC nodes for scalar types have a cd impl size attribute, which is of the private type value. Unlike the attributes corresponding to other kinds of representation clauses, cd impl size does not necessarily contain the value given in a length clause. It was introduced to facilitate the evaluation of static expressions. DIANA always records the value of static expressions; however, the static values of certain Ada attributes are implementation dependent. Since these attributes are related to static types, it is convenient to store this information with the node representing the type.

One such attribute is SIZE, which returns the actual number of bits required to store any object of that type. The value of this attribute is recorded with the cd impl size attribute, which has a value even if no length clause is given for the type. A length clause merely specifies the upper bound for the size of objects of that type, hence it is possible for the value of cd impl size to be smaller than that given in a length clause. Because the Ada programming language restricts static types to the scalar types, this implementation dependent attribute is not necessary for the nodes representing

non-scalar types.

The other implementation dependent attribute defined in DIANA is the cd impl small attribute for nodes representing fixed point types. It contains the value to be returned for the Ada attribute SMALL. The user may specify in a length clause a value for "small" (the smallest positive model number for the type or first named subtype); this value is used in representing values of that fixed point type, and may affect storage requirements for objects of that type. If no length clause is given, then cd impl small will contain the value for "small" selected by the implementation; in this case "small" for the base type may differ from "small" for subtypes of that base type [ARM, 3.5.9].

Section 4.5

CONSTRAINTS

4.5 CONSTRAINTS

The Ada programming language defines five kinds of constraints: range, floating point, fixed point, index, and discriminant. Because constraints are generally imposed on types or subtypes, DIANA handles constraints in a manner that is similar to the way in which types and subtypes are treated.

There are both syntactic and semantic representations of certain constraints in DIANA. However, the differences between the two are not as rigidly observed for constraints as for types and subtypes. This is due to an effort to reduce the number of nodes in the DIANA tree, and to the fact that in many cases the syntactic representation of a constraint is also suitable for semantic processing.

As a result, there are not two distinct classes for representing constraints. In general, the class `CONSTRAINT` represents the syntax of the various constraints; there is no class defined to represent a semantic version of a constraint. Although certain `TYPE_SPEC` nodes (which represent the semantic concept of a type or subtype) define an attribute to denote a constraint, if a node from class `CONSTRAINT` is appropriate then it is referenced rather than requiring a new "semantic" structure to be built.

To facilitate the process of constraint checking, an effort was made to represent the constraints in DIANA in as consistent a manner as possible. The `CONSTRAINT` node is not always suitable for the following kinds of constraints: discriminant, floating point, fixed point, and index.

A discriminant constraint is a series of discriminant associations. The sequence of associations may contain a mixture of `EXP` and `assoc` nodes (i.e. expressions and named associations); if named associations are used then the associations do not even have to appear in the order in which the discriminants are declared. Thus an additional sequence, designated by the `sm normalized dscrm t s` attribute of the `constrained record` node, is created for a discriminant constraint. This sequence is a normalized version of the syntactic sequence -- all named associations are replaced by the associated expressions, in the order in which the corresponding discriminants are declared. In the interest of economy, if the discriminant constraint appears in the source text in the normalized form, then the record subtype specification may reference the same sequence of expressions that the discriminant constraint denotes.

A different problem arises for fixed or floating point constraints in `TYPE_SPEC` nodes. A type specification in DIANA records the applicable constraint. Because a fixed or floating point constraint contains two parts,

either of which is optional in a subtype declaration, it is possible for the accuracy definition and the range constraint to be given in two different constraints. Thus it is not sufficient for a **REAL** node to reference a **REAL CONSTRAINT** node. Instead, the accuracy definition and the range constraint are recorded by separate attributes (sm accuracy and sm range) in the **REAL** node. Though the type specification does not reference a **REAL CONSTRAINT** node, it may possibly reference one or both of the constituents of a **REAL CONSTRAINT** node.

The final kind of constraint to have an additional semantic representation is the index constraint. DIANA adheres to the semantics of the Ada language in its representation of arrays created by constrained array definitions. An index constraint for a **constrained_array** node introduced by a constrained array definition is a sequence of discrete type specifications; if an index subtype is given by a type mark then the type specification corresponding to the type mark appears at that index position. Otherwise, an anonymous subtype is created for that particular index position. To allow array subtypes to be treated in a uniform manner, the same approach is taken for the index constraints of all constrained array subtypes -- those introduced by subtype declarations, slices, aggregates, etc. (some of these may be anonymous). The new sequence is denoted by the sm index subtype s attribute of the **constrained_array** node.

It may be necessary to make copies of some constraints. The Ada programming language allows multiple object declarations, which are equivalent to a series of single object declarations. If the multiple object declaration contains a constrained array definition then the type of each object is unique; if the declaration contains a subtype indication with a constraint, then the subtype of each object is unique. In either case, a new **TYPE_SPEC** node is created for each object in the identifier list. If the constraint is non-static then each type specification has a unique constraint. Because the constraint designated by the as type def attribute of the object declaration is not designed to be used for semantic processing, that constraint may be "shared" with one of the **TYPE_SPEC** nodes.

Due to structural similarities, the class **RANGE** represents both an Ada range and an Ada range constraint. The difference can always be determined from the context. If the **RANGE** node is introduced by an as constraint attribute, as in the case of a numeric type definition or a subtype indication, then it represents a range constraint. Otherwise, it is a simple range (i.e. it is introduced by a loop iteration scheme, a membership operator, an entry declaration, a choice, or a slice). A **RANGE** node appearing **DIRECTLY** in a sequence of **DISCRETE_RANGE** nodes (corresponding to an index constraint) is also a simple range.

In order to avoid a multiple class membership for the class **RANGE**, which when representing a range constraint should belong to class **CONSTRAINT**, and when denoting a simple range should be a member of class **DISCRETE_RANGE**, the classes **CONSTRAINT** and **DISCRETE_RANGE** were merged. Consequently, **CONSTRAINT** is a combination of the Ada syntactic categories "constraint" and "discrete_range". By including **DISCRETE_RANGE** in class **CONSTRAINT**, the discrete_subtype node was introduced into the class representing constraints. It was therefore necessary to add a restriction in the semantic specification of DIANA prohibiting an attribute having the type **CONSTRAINT** from referencing a discrete_subtype node.

Discrete subtype indications are represented by the node discrete_subtype. Although discrete subtype indications are syntactically identical to any other kind of subtype indication, the subtype_indication node could not be included in class DISCRETE_RANGE because it is already a member of class TYPE_DEF; to do so would have introduced multiple membership for node subtype_indication. Hence the discrete_subtype node was introduced. It has an as_subtype_indication attribute which denotes the actual subtype indication, thus discrete_subtype serves as an intermediate node.

When a range constraint, a floating point constraint, or a fixed point constraint is imposed on a type or subtype, it is necessary to perform constraint checks to insure that the constraint is compatible with the subtype given by the type mark. Unfortunately, the information required to do this is not incorporated in the corresponding type specification. Although a SCALAR node does have an sm_base_type attribute, it does not necessarily denote the type specification corresponding to the type mark in the subtype indication (a scalar subtype is constructed from the BASE TYPE of the type mark, not the type mark itself).

To make the type specification corresponding to the type mark accessible from the type specification of the new subtype, the sm_type_spec attribute was defined for the classes RANGE and REAL_CONSTRAINT. Although a range constraint may be part of a floating point or fixed point constraint, it was not sufficient to add sm_type_spec to the RANGE node alone; the accuracy definition must be available as well. The definition of this attribute for both classes results in redundancy for the range constraints which are part of fixed or floating point constraints. The sm_type_spec attributes of the REAL_CONSTRAINT node and the corresponding RANGE node (if there is one) always denote the same type specification.

If the constraints are associated with a subtype indication then sm_type_spec denotes the type specification of the type mark; however, RANGE and REAL_CONSTRAINT nodes can appear in other contexts. For instance, both may appear in type definitions. The expressions for the bounds of a range constraint associated with a type definition are not required to belong to the same type, therefore it is not feasible for sm_type_spec to reference a previously defined type. In this case sm_type_spec designates the type specification of the new base type.

RANGE nodes representing (discrete) ranges rather than range constraints can appear as a part of slices, entry family declarations, loop iteration schemes, membership operators, index constraints, and choices. In each of these cases the bounds must be of the same type, hence sm_type_spec denotes the appropriate base type, as specified in the Ada Reference Manual. For example, the Ada Reference Manual states that "for a membership test with a range, the simple expression and the bounds of the range must be of the same scalar type" [ARM, 4.5.2]; therefore sm_type_spec for a RANGE node associated with a membership operator denotes the type specification of that scalar type.

A RANGE attribute is represented by a different kind of node from the other Ada attributes. Unlike the others (except for BASE, which is another special case), the RANGE attribute does not return an expression; thus the attributes sm_value and sm_exp_type (defined for the other kinds of Ada attributes) do not apply. In addition, the RANGE attribute does not appear in the same contexts as

other Ada attributes. Consequently it is represented by a special
range_attribute node.

Section 4.6

EXPRESSIONS

4.6 EXPRESSIONS

Expressions in a DIANA structure are represented by nodes from class EXP. EXP also contains the class NAME because certain names can appear in expressions.

The nodes representing expressions record both the syntax and the semantics of expressions; therefore nodes in this class contain both structural and semantic attributes, and may be denoted by both structural and semantic attributes.

There are two kinds of expressions which have a syntactic component that may vary: the membership operator may contain either a type mark or a range, and the allocator may contain either a qualified expression or a subtype indication. Unfortunately, in each case the variants do not belong to the same DIANA class, therefore a single attribute could not be defined to represent the syntactic component. The DIANA solution was to define two variants for each of these expressions, each variant having the appropriate structural attribute to record the syntax of that particular variant. The membership operator is represented by the range_membership and type_membership nodes, and the allocator is represented by the qualified_allocator and subtype_allocator nodes.

All DIANA nodes representing expressions have an sm_exp_type attribute; it denotes the subtype of the expression. The subtype is referenced rather than the base type because the type specification of the subtype contains both the applicable constraint AND a direct path to the specification of the base type. In this way, all nodes representing expressions contain the information necessary for semantic checking, constraint checking, etc. It should be noted that this does not imply that sm_exp_type can never denote a base type -- in the Ada programming language a type is not only a type, but an unconstrained subtype as well.

Some expressions can have static values (see section 4.9 of the Ada Reference Manual). The sm_value attribute was defined for nodes which can represent static expressions to permit the static value to be obtained without traversing any corresponding subtrees. If the value of an expression represented by a node having an sm_value attribute is not static, then sm_value must have a distinguished value indicating that it is not evaluated.

Due to syntactic similarities, various nodes in class EXP can represent entities other than expressions. The selected node not only represents selected components of records, it represents expanded names as well. The indexed node represents an indexed component; however, it may also denote a member of an

entry family. These nodes have the attributes sm value and sm exp type because they can represent expressions; however, since these attributes are meaningless for anything other than an expression, they are undefined if the node does not represent an expression (an expanded name denoting an object or a literal is considered an expression).

4.6.1 EXPRESSIONS WHICH INTRODUCE ANONYMOUS SUBTYPES

Certain expressions (such as slices) impose a new constraint on a type. To enable the subtypes of expressions to be treated in a consistent manner, DIANA requires that anonymous subtypes be created for these expressions. The expressions which may introduce anonymous subtypes are slices, aggregates, string literals, and allocators.

Although a constraint for one of these expressions may be explicit, it is not necessarily different from an existing constraint. In the interest of efficiency, DIANA allows an existing type specification to be referenced as the subtype of the expression if it can be STATICALLY determined that the constraints are identical; however, an implementation is free to create an anonymous subtype for each such expression if it finds that approach to be more convenient. For example, if it can be determined statically that a slice has the same bounds as the array prefix, then the slice node is allowed (but not required) to denote the type specification of the array prefix as its subtype. If it can be determined statically that an aggregate or string literal has the same constraints as the context type (which is required to be determinable from the context alone) then the type specification of the context type may be referenced as the subtype of the expression.

The anonymous subtype is constructed from the appropriate base type and the new constraint. The base type for a slice is obtained from the array prefix, and the constraint is the discrete range. The base type for an aggregate or a string literal is taken from the context; determining the constraint for these expressions is more complicated (the constraint is not necessarily explicit). Sections 4.2 and 4.3 of the Ada Reference Manual discuss this procedure in detail.

An allocator containing a subtype indication with an explicit constraint introduces an anonymous subtype. This subtype is not necessarily that of the object created by the allocator (for further details, see section 4.6.5); however, a new type specification is created for it because constraint checks must be performed to ensure that the constraint is compatible with the type mark.

Unlike the other expressions which create anonymous subtypes, the allocator does not introduce the anonymous subtype via the sm exp type attribute. Though an allocator creates a new object, it RETURNS an access value. The anonymous subtype is not the subtype of the access value returned by the allocator, hence it cannot be denoted by sm exp type. The sm desig type attribute was defined for allocators containing subtype indications; it denotes the type specification corresponding to the subtype indication (if an explicit constraint is not given then sm desig type references the type specification of the type mark).

4.6.2 FUNCTION CALLS AND OPERATORS

The Ada programming language allows operators (both predefined and user-defined) to be given in either prefix or infix form. In addition, a function can be renamed as an operator, and an operator renamed as a function. Consequently, the form of use of a function or operator implies nothing about whether the function or operator is predefined or user-defined. Since it serves no semantic purpose to distinguish function calls from operators, all function calls and operators are represented as function calls in a DIANA structure.

There are two exceptions to this method of representation: the short-circuit operators and the membership operators. These operators cannot be represented as functions, therefore they cannot be overloaded. Unlike the parameters of a function call, all of which are evaluated before the call takes place, the evaluation of the second relation of a short-circuit operator is dependent upon the result of the evaluation of the first relation. The second relation is not evaluated when the first relation of an "and then" operator is "true" or when the first relation of an "or else" operator is "false". A membership operator requires either a type mark or a range, neither of which is an expression, hence neither can be represented as a parameter. These operators are represented by the `short_circuit` and `MEMBERSHIP` nodes rather than `function_call` nodes.

The name of the function (a used occurrence) provides access to the defining occurrence of the function or operator, making it possible to determine the kind of function or operator represented by the `function_call`. The `lx_prefix` attribute records whether the call is given in prefix or infix form; this information is required for subprogram specification conformance rules (the default values of a parameter of mode "in" might be a function call or operator).

The subtype of a function call is considered to be the return type. If the function call is a predefined operator then the return type is the appropriate base type, as specified in section 4.5 of the Ada Reference Manual. This means that the subtypes of certain function calls may be unconstrained; for example, the result of a catenation is always of an unconstrained array subtype. Since it is not always possible to determine statically the constraints on a value returned by a function call, it is not feasible to require an anonymous subtype to be created for a call to a function with an unconstrained return type.

4.6.3 IMPLICIT CONVERSIONS

The Ada programming language defines various kinds of implicit type conversions, some of which are recorded in a DIANA structure, while others are not.

An implicit conversion of an operand of a universal type to a numeric type may be required for an operand that is a numeric literal, a named number, or an attribute. Although this implicit conversion is not recorded by the introduction of a distinct node, it is in a sense recorded by the value of the `sm_exp_type` attribute. If the context requires an implicit conversion of an operand of a universal type, then the `sm_exp_type` attribute of the

numeric_literal, used_object_id, or attribute node denotes the target type rather than the universal type.

By allowing the sm_exp_type attribute to reflect the result of the implicit conversion, all of the information necessary to perform the conversion is recorded in the node representing the literal, named number, or attribute; no additional context information is required. In addition, the fact that an expression is the operand of an implicit conversion can now be determined easily by a DIANA user. For instance, a numeric literal is the operand of an implicit conversion if sm_exp_type does not denote a universal type. If sm_exp_type did not reflect the conversion, then in any context in which an operand of a universal type would not be appropriate it would be necessary to check for the existence of a convertible universal operand. Since scalar operands can appear in numerous contexts that require non-universal types, a substantial amount of checking would be involved. The DIANA approach localizes the checking for an implicit conversion to the nodes which may represent convertible universal operands.

The semantics of the Ada language force the determination of the existence of an implicit type conversion during the semantic checking phase (an implicit conversion is applied only if the innermost complete context requires the conversion for a legal interpretation); recording information that is already available should not impose a hardship on an implementation. The numeric_literal, used_object_id, and attribute node all represent used occurrences; hence no conflicts should arise as a result of this representation of implicit conversions (i.e. the sm_obj_type attribute of the number_id still denotes a universal type).

As a result of the DIANA representation of implicit conversions, the used occurrences of a named number cannot always be represented by a single node, since the sm_exp_type attribute of the used_object_id may reflect an implicit conversion. However, a single used occurrence having a particular target type may represent all used occurrences of that named number requiring that particular type.

If the variable to the right of the assignment operator in an assignment statement is an array, then the expression to the right of the assignment operator is implicitly converted to the subtype of the array variable. This implicit subtype conversion may also be performed on the initial value in an array variable declaration. Many kinds of expressions produce anonymous array subtypes, which have a DIANA representation. Since this representation is introduced by the sm_exp_type attribute of the corresponding expression, the solution adopted for scalar operands is not suitable for arrays. Due to the fact that the implicit subtype conversion can occur only in two well-defined contexts, it was decided that it was not necessary to record the need for an implicit conversion.

Certain type conversions take place during a call to a derived subprogram. For formal parameters of the parent type the following conversions are performed: the actual parameters corresponding to parameters of mode "in" and "in out" are converted to the parent type before the call takes place; parameters of mode "in out" and "out" are converted to the derived type after the call takes place. If the result of a derived function is of the parent type then the result is converted to the derived type.

The conversion of parameters described above cannot be represented in the sequence of actual parameter associations corresponding to the source code without interfering with source reconstruction; however, these conversions could be incorporated into the normalized actual parameter list. It was decided not to record these conversions because the need for such a conversion is easily detected by comparing the base types of the formal and actual parameters. Since an implementation is already required to compare the (sub)types of formal and actual parameters to determine which constraint checks are needed, checking for the need for implicit conversions should impose no hardship. Requiring these conversions to be represented would force calls to derived subprograms to be treated as special cases when constructing a DIANA structure. The conversion of a return value of the parent type is not represented for the same reasons.

4.6.4 PARENTHEZIZED EXPRESSIONS

Under some circumstances parentheses have a semantic effect in the Ada programming language. Consider the following procedure call:

```
P ( (A) );
```

The parentheses around the actual parameter "A" make it an expression rather than a variable, hence the corresponding formal parameter must be of mode "in", or the program containing this statement is in error. In addition, certain parentheses (such as those contained in default expressions for formal parameters of mode "in") must be preserved in order to perform conformance checks. Hence DIANA defines a **parenthesized node**. Not only does it contain a reference to the expression that it encloses, it records the value (if the value is static) and the subtype of that expression.

Certain kinds of processing are not affected by the presence or absence of parentheses. To allow the **parenthesized node** to be easily discarded as the DIANA is read in, a restriction was added to the semantic specification of DIANA: a semantic attribute which denotes an expression can never reference a **parenthesized node**; it must designate the node representing the actual expression instead. This principle also applies to sequences which are created expressly for semantic attributes and may contain expressions, such as the various normalized sequences. As a consequence of this restriction, a **parenthesized node** can be referenced by only one attribute -- a structural one. Since many of the semantic attributes were introduced as "shortcuts", it would be inappropriate for them to denote a **parenthesized node** anyway.

4.6.5 ALLOCATORS

The subtype of an object created by an allocator is determined in one of two ways, depending on the class of the object. The subtype of an array or a discriminated object is determined by the qualified expression, subtype indication, or default discriminant values. The subtype of any other kind of object is "the subtype defined by the subtype indication of the access type definition" [ARM, 4.8]; i.e. it is the subtype determined by the context (the Ada language requires this type to be determinable from the context alone).

As a result of these requirements, the sm exp type attribute of an allocator creating an object that is not an array or a discriminated object denotes the type specification of the context subtype. Unfortunately, the value of sm exp type is not as easily determined in the other case -- an appropriate subtype is not always available for the sm exp type attribute of an allocator creating an array or a discriminated object. Since an allocator can create an object with a unique constraint, a collection that is compatible with that object may not exist. Consider the following declarations:

```
type AC is access STRING(1..10);
```

```
FIVE : POSITIVE := 5;
```

```
OBJ : AC := new STRING(1..FIVE);
```

Although the initialization of OBJ will result in a constraint error, the declaration of OBJ is legal, and hence must be represented in the DIANA structure.

It may seem that it would be simple to make an anonymous subtype for this sort of allocator, just as anonymous subtypes are created for other kinds of expressions. But due to the way in which access types are constrained, the construction of an anonymous subtype cannot always be performed as it would be for other classes of types.

The anonymous subtypes for other expressions are constructed from the base type of the context type and the new constraint. The base type of an array or record type cannot have a constraint already imposed upon it (constrained array type definitions create anonymous unconstrained base types, and the syntax of a record type definition does not allow a constraint); therefore the imposition of a constraint on the base type does not cause an inconsistency.

The base type of an access type is not always unconstrained, nor does the Ada language define an anonymous unconstrained base type for a constrained access type. Associated with an access base type is a collection containing the objects which are referenced by access values of that type. If that base type is constrained (i.e. the designated subtype is constrained), then all of the objects in its collection must have the same constraints. It would be inappropriate to introduce an anonymous base type having an unconstrained designated subtype.

Unfortunately, this means that there is no existing type that would be an appropriate base for the anonymous subtype of the allocator in the previous example. The objects which may be referenced by OBJ and the object created by the evaluation of the allocator do not belong to the same collection, therefore they should not have the same base type. One solution would be to create an anonymous BASE type for the allocator; however, it cannot always be determined statically whether or not the object created by an allocator belongs to the collection of the context type. For instance, if the variable FIVE had the value 10 rather than 5, then it would be inconsistent to construct an anonymous base type for the allocator, since the object it creates belongs to the collection associated with AR.

It was decided that in the case of an allocator creating an array or a discriminated object the sm exp type attribute would denote the context subtype, just as it does for other kinds of allocators. Within the context of the allocator it can easily be determined what constraint checks need to be performed by comparing the subtype of the qualified expression or the subtype introduced by the allocator with the designated subtype of the context type.

4.6.6 AGGREGATES AND STRING LITERALS

The Ada programming language allows the component associations of an aggregate to be given in two forms: named and positional. If named associations are used then the associations do not necessarily appear in the same order as the associated components. To simplify subsequent processing of the aggregate, the aggregate node contains a normalized list of component associations.

Since records have a static number of components (the expression for a discriminant governing a variant part must be static in an aggregate), it is possible for the component associations to be replaced by a sequence of expressions in the order of the components to which they correspond.

Unfortunately, the associations of array aggregates are not necessarily static. In addition, it is not always desirable to replace a static range by the corresponding number of component expressions, particularly if the range is large. Hence the normalized list of component associations for an array aggregate does not necessarily consist of expressions alone (obviously all positional associations will remain as expressions in the normalized sequence).

A single component association may contain several choices. Since the component associations in the normalized sequence must be in the proper order, and since the original choices do not necessarily correspond to components which are contiguous (much less in the proper order), each component association containing more than one choice is decomposed into two or more associations. The normalized sequence does not correspond to source code, hence the only requirements imposed on the decomposition process are that the resulting associations be semantically equivalent to the original ones, and that each association be either the component expression itself or a named association having a single choice.

An "others" choice does not necessarily denote consecutive components, therefore it is treated as if it were an association with multiple choices. Each component or range of components represented by the "others" choice is represented by a component expression or a named association in the normalized sequence.

If a choice in an array aggregate is given by a simple expression, and it can be determined statically that the expression belongs to the corresponding index subtype then that association may be replaced by the component expression.

A subaggregate is syntactically identical to an aggregate, therefore it is represented in a DIANA structure by the same kind of node. The only problem arising from this representation is caused by the sm exp type attribute. A

subaggregate is an aggregate corresponding to a sub-dimension of a multidimensional array aggregate. An aggregate corresponding to an array component or a record component is NOT a subaggregate. Since a subaggregate corresponds to a dimension rather than a component, it does not have a subtype. A subaggregate does, however, have bounds (although the bounds may be implicit, as specified in section 4.3.2 of the Ada Reference Manual). In order to correctly represent the subaggregate, the sm discrete range attribute was defined for the aggregate node; it denotes the bounds of the subaggregate, and is void for an aggregate that is not a subaggregate. The sm exp type attribute of a subaggregate is void.

A string literal is not syntactically like an aggregate, therefore it is represented by a string_literal node. However, a string literal may be a subaggregate if it occurs "in a multidimensional aggregate at the place of a one-dimensional array of a character type" [ARM, 4.3.2]. To accomodate this case, the string_literal and aggregate nodes were placed in the class AGG_EXP, and the sm discrete range attribute was defined for both nodes.

As previously stated, an aggregate may have an anonymous subtype. In most cases the constraints for the subtype are obtained from the aggregate itself with no conflict as to which constraints to use. However, in the case of an aggregate which contains more than one subaggregate for a particular dimension, the choice is not clear. To add to the confusion, the bounds of the subaggregates for a particular dimension are not necessarily the same. Though the Ada language requires a check to be made that all of the (n-1)-dimensional subaggregates of an n-dimensional multidimensional array aggregate have the same bounds, a program containing a violation of this condition is not in error; instead, a constraint error is raised when the aggregate is evaluated during execution.

DIANA does not specify which subaggregate the constraint for a particular dimension is taken from. If all of the subaggregates have the same bounds then it does not matter which is chosen. If the bounds are not the same then it still does not matter, since the constraint error will be detected regardless of which bounds are selected for the anonymous subtype.

Section 4.7

PROGRAM UNITS

4.7 PROGRAM UNITS

Numerous kinds of declarations exist for package and subprograms -- renaming declarations, generic instantiations, etc. The information peculiar to each kind of declaration must be accessible from the defining occurrence of that entity. Rather than have a different kind of defining occurrence with different attributes for each kind of declaration, DIANA has only one for a package and one for each kind of subprogram. Each such defining occurrence has an sm unit desc attribute which denotes a UNIT_DESC node that not only indicates the form of declaration, but records pertinent information related to the entity as well. The UNIT_DESC nodes for special kinds of package and subprogram declarations are discussed in detail in the following sections.

The defining occurrence of a package or subprogram that is introduced by an ordinary declaration does not denote a UNIT_DESC node defined exclusively for a particular kind of declaration. Instead, it denotes the body of the subprogram or package, if it is in the same compilation unit. Although this information is not vital for a defining occurrence that does not correspond to a body declaration, this "shortcut" may be used for optimization purposes.

4.7.1 RENAMED UNITS

The Ada programming language allows renaming declarations for packages, subprograms, and entries. These declarations introduce new names for the original entities. In a few special cases an entity may even be renamed as another kind of entity. A package or subprogram renaming declaration has the same DIANA structure as an ordinary package or subprogram declaration; the fact that it is a renaming is indicated by the as unit kind attribute, which denotes a renames_unit node.

If the entity is being renamed as the same kind of entity (i.e. a package is being renamed as a package, a procedure as a procedure, etc.) then uses of the new name will have the same syntactic structure as uses of the old name, and can appear in the same kinds of context. For instance, a used occurrence of the name of a function which is renamed as a function will appear as a function call within the context of an expression. The function call must be given in prefix form, just as a function call containing the old name must. A function_id can represent the new name without conveying any incorrect semantic information, and used occurrences of this name can refer to the function_id without introducing any inconsistencies in the DIANA tree.

In such cases the new name is represented by the same kind of DEF_NAME node as the original entity, the sm_unit_kind attribute of which denotes a renames_unit node. Because the defining occurrence represents a new name rather than a new entity, the remainder of the semantic attributes, except for sm_spec for a subprogram name, have the same values as those of the original entity. Since a new formal part is given in the renaming of a subprogram, the sm_spec attribute must denote the formal part corresponding to the new name. Access to the defining occurrence of the original unit is provided through the as_name attribute of the renames_unit node.

Entities which are renamed as other kinds of entities present special cases. Consider a function renamed as an operator. Although a used occurrence of the new name will still appear as a function call within the context of an expression, a function call using the new name may be given in either infix or prefix form. If a function_id were used to represent the new name rather than an operator_id then the information conveyed by the type of the defining occurrence node would not be correct. Though the entity is the same function, its new name must be viewed as the name of an operator. The same is true for an attribute renamed as a function -- though a used occurrence returns the value of the attribute, it will look like a function call, not an attribute.

An entry renamed as a procedure presents a different problem. The syntax for procedure calls and entry calls is identical; however, from a semantic perspective, call statements using the new name are procedure calls, not entry calls. A call statement containing the new name cannot be used for the entry call statement in a conditional or timed entry call, nor can it be the prefix for a COUNT attribute.

With the exception of an enumeration literal renamed as a function, all entities which are renamed as other kinds of entities are represented by the DEF_NAME node which is appropriate for the new name. Applicable attributes in the defining occurrence for the new name have the same values as the corresponding attributes in the original entity. For instance, the operator_id and function_id nodes have the same attributes, so that all semantic attributes except for sm_unit_kind and sm_spec may be copied. On the other hand, none of the semantic attributes in a function_id are applicable for an Ada attribute, hence they should have the appropriate values; i.e. sm_is_inline is false, sm_address is void, etc.

The only entity which can be renamed as another kind of entity without changing either the syntactic or the semantic properties associated with the use of the name is an enumeration literal that is renamed as a function. An enumeration literal and a parameterless function call have the same appearance, and there are no semantic restrictions placed on the use of the new name. The new name can be represented by an enumeration_id, and used occurrences can be denoted by used_object_id nodes which reference that enumeration_id (rather than a function_id) as the defining occurrence. The values of the semantic attributes of the new enumeration_id are copies of those of the original enumeration_id.

4.7.2 GENERIC INSTANTIATIONS

The Ada language defines a set of rules for an instantiation, specifying which entity is denoted by each kind of generic formal parameter within the generic unit. For example, the name of a generic formal parameter of mode "in out" actually denotes the variable given as the corresponding generic actual parameter. An obvious implementation of generic instantiations would copy the generic unit and substitute the generic actual parameters for all uses of the generic formal parameters in the body of the unit; however, this substitution cannot be done if the body of the generic unit is compiled separately. In addition, a more sophisticated implementation may try to optimize instantiations by sharing code between several instantiations. Therefore the body of a generic unit is not copied in DIANA in order to avoid constraining an implementation and to avoid introducing an inconsistency in the event of a separately compiled body.

Generic formal parameters may appear in the specification portion of the generic unit; for instance, a formal parameter of a generic subprogram may be declared to be of a generic formal type. The specification portion of the instantiated unit will necessarily be involved in certain kinds of semantic processing whenever the instantiated unit or a part of its specification is referenced. For example, when that instantiated subprogram is called it is necessary to know the types of its parameters. Semantic processing would be facilitated if the entities given in the specification could be treated in a "normal" fashion; i.e. it is desirable that the appropriate semantic information be obtainable without a search for the generic actual parameter every time semantic information is needed. Because there may be numerous instantiations of a particular generic unit, it is not possible to simply add an additional attribute to the defining occurrences of the generic formal parameters in order to denote the corresponding actual parameters.

DIANA provides a solution in two steps, the first of which is the addition of a normalized list of the generic parameters, including entries for all default parameters. Within this sequence (sm_decl_s of the instantiation node) each parameter entry is represented by a declarative node which does not correspond to source code. Each declarative node introduces a new defining occurrence node; the name (lx_symrep) corresponds to the formal parameter, however, the values of the semantic attributes are determined by the actual parameter as well as the kind of declarative node introducing the defining occurrence.

After the normalized declaration list has been created the specification part of the generic unit is copied. Every reference to a generic formal parameter in the original generic specification is changed to reference the corresponding newly created defining occurrence. Since each DEF_NAME node contains the appropriate semantic information, specifications of instantiated units do not have to be treated as special cases.

A DEF_NAME node introduced by one of these special declarative nodes is not considered to be an additional defining occurrence of the generic formal parameter; should a defining occurrence that is introduced by such a declarative node have an sm_first attribute, it will reference itself, not the node for the formal parameter.

Since this list of declarative nodes is a normalized list, all of the object declarations which appear in it are SINGLE declarations, even though the generic formal parameter may have been declared originally in a multiple object declaration. The kind of declarative node created for a generic formal parameter is determined by the kind of parameter as well as by the entity denoted by the parameter.

The name of a formal object of mode "in" denotes "a constant whose value is a copy of the value of the associated generic actual parameter" [ARM, 12.3]. Thus a formal object of mode "in" is represented by a constant declaration in the normalized parameter list. The initial value is either the actual parameter or the default value, and the subtype of the constant is that of the actual parameter.

The name of a formal object of mode "in out" denotes "the variable named by the associated actual parameter" [ARM, 12.3]. Hence a formal object of mode "in out" appears in the normalized parameter list as a renaming declaration in which the renamed object is the actual parameter. The values of the attributes of the new `variable_id` are determined just as they would be for an ordinary renaming.

The declarative nodes for both constant and variable declarations have an attribute for the type of the object being declared. Unfortunately, `as type def` is normally used to record syntax, but because the declarative node does not correspond to source code, there is no syntax to record. A possible solution would be for `as type def` to reference the `TYPE_DEF` structure belonging to the declaration of the actual parameter; however, this structure is not always appropriate. If the context of the declaration of the actual parameter and that of the instantiation is not the same, then an expanded name rather than a simple name might be required in the `TYPE_DEF` structure for the special declarative node. Rather than force an implementation to construct a new `TYPE_DEF` structure in order to adhere to the Ada visibility rules, DIANA allows the value of `as type def` in an `OBJECT_DECL` node generated by an instantiation to be undefined. Since these declarative nodes are introduced to facilitate semantic processing, not to record syntax, this solution should not cause any problems. Declarative nodes for objects in the copy of the specification are treated in the same manner.

The name of a formal type denotes "the subtype named by the associated generic actual parameter (the actual subtype)" [ARM, 12.3]. A generic formal type is represented in the normalized list by a subtype declaration. The name in the subtype indication corresponds to the generic actual parameter, and the subtype indication does not have a constraint, hence the declaration effectively renames the actual subtype as the formal type. The `sm type spec` attribute of the `subtype_id` references the `TYPE_SPEC` node associated with the actual parameter.

The name of a formal subprogram denotes "the subprogram, enumeration literal, or entry named by the associated generic actual parameter (the actual subprogram)" [ARM, 12.3]. A generic formal subprogram appears in the normalized list as a renaming declaration in which the newly created subprogram renames either the subprogram given in the association list or that chosen by the analysis as the default. The values of the attributes of the new `DEF_NAME` node are determined just as they would be for an ordinary renaming, with the exception of the `HEADER` node, which is discussed in one of the subsequent

paragraphs.

References to generic formal parameters are not the only kind of references that are replaced in the copy of the generic specification. Substitutions must also be made for references to the discriminants of a generic formal private type, and for references to the formal parameters of a generic formal subprogram.

The name of a discriminant of a generic formal type denotes "the corresponding discriminant (there must be one) of the actual type associated with the generic formal type" [ARM, 12.3]. If a formal type has discriminants, references to them are changed to designate the corresponding discriminants of the base type of the newly created subtype (i.e. the base type of the actual type). Since the new `subtype_id` references the type specification of the actual subtype, any direct manipulation of the `subtype_id` will automatically access the correct discriminants.

The name of a formal parameter of a generic formal subprogram denotes "the corresponding formal parameter of the actual subprogram associated with the formal subprogram" [ARM, 12.3]. If a formal subprogram has a formal part, the declarative node and defining occurrence node for the newly created subprogram reference the `HEADER` node of the the actual subprogram. Any references to a formal parameter are changed in the copy of the generic unit specification to denote the corresponding formal parameter of the actual subprogram.

Consider the following example:

procedure EXAMPLE is

```
    OBJECT : INTEGER := 10;
```

```
    function FUNC ( DUMMY : INTEGER ) return BOOLEAN is
    begin
        return TRUE;
    end FUNC;
```

```
    generic
        FORMAL_OBJ : INTEGER;
        with function FORMAL_FUNC( X : INTEGER ) return BOOLEAN;
    package GENERIC_PACK is
```

```
        PACK_OBJECT : BOOLEAN := FORMAL_FUNC ( X => FORMAL_OBJ );
```

```
    end GENERIC_PACK;
```

```
    package body GENERIC_PACK is separate;
```

```
    package NEW_PACK is new GENERIC_PACK ( FORMAL_OBJ => OBJECT,
                                             FORMAL_FUNC => FUNC );
```

```
begin
    null;
end EXAMPLE;
```

If a DIANA structure were created for package EXAMPLE, then the normalized parameter list for package NEW_PACK would contain two declarative nodes. The first would be a constant declaration for a new FORMAL_OBJ, which would be initialized with the INTEGER value 10. The second would be a renaming declaration for a new FORMAL_FUNC; the original entity would be FUNC, and the header of the new FORMAL_FUNC would actually be that of FUNC. The specification for package NEW_PACK would be a copy of that of GENERIC_PACK; however, the references to FORMAL_FUNC and FORMAL_OBJ would be changed to references to the newly declared entities, and the reference to X would be changed to a reference to DUMMY.

4.7.3 TASKS

The definition of the Ada programming language specifies that "each task depends on at least one master" [ARM, 9.4]. Two kinds of direct dependence are described in the following excerpt (section 9.4) from the Ada Reference Manual:

- (a) The task designated by a task object that is the object, or a subcomponent of the object created by the evaluation of an allocator depends on the master that elaborates the corresponding access type definition.
- (b) The task designated by any other task object depends on the master whose execution creates the task object.

Because of the dynamic nature of the second kind of dependency, DIANA does not attempt to record any information about the masters of such task objects. The first kind of dependency, however, requires some sort of information about the static nesting level of the corresponding access type definition; hence the sm_master attribute was added to the type specification of access types. Its value is defined only for those access types which have designated types that are task types. This attribute provides access to the construct that would be the master of a task created by the evaluation of an allocator returning a value of that particular access type.

A master may be one of the following:

- (a) a task
- (b) a currently executing block statement
- (c) a currently executing subprogram
- (d) a library package

A problem arose over the type of sm_master -- there is no one class in DIANA that includes all of these constructs. The class ALL_DECL contains declarative nodes for tasks, subprograms, and packages; therefore it seemed appropriate to add a "dummy" node representing a block statement to this class. The block_master node, which contains a reference to the actual block statement,

was added to ALL_DECL at the highest possible level, so that it would not be possible to have block master nodes appearing in declarative parts, etc. Only one attribute (as all decl) other than sm master has the class ALL_DECL as its type; restrictions on the value of this attribute were added to the semantic specification.

4.7.4 USER-DEFINED OPERATORS

The Ada programming language allows the user to overload certain operators by declaring a function with an operator symbol as the designator. Because these user-declared operators have user-declared bodies, etc., they are represented by a different kind of node from the predefined operators. The predefined operators are represented by bltn_operator_id nodes, which do not have the facility to record all of the information needed for user-defined operators. A user-defined operator is represented by an operator_id node; it has the same set of attributes as the function_id.

A special case arises for the inequality operator. The user is not allowed to explicitly overload the inequality operator; however, by overloading the equality operator, the user IMPLICITLY overloads the corresponding inequality operator. The result returned by the overloaded inequality operator is the complement of that returned by the overloaded equality operator.

Since the declaration of the overloaded inequality operator is implicit, the declaration is not represented in the DIANA tree (to do so would interfere with source reconstruction). At first glance it may seem that a simple implementation of the implicitly declared inequality operator would be to replace all uses of the operator by a combination of the "not" operator and the equality operator (i.e. " $X \neq Y$ " would be replaced by " $\text{not } (X = Y)$ "). While this approach may be feasible for occurrences of the inequality operator within expressions, it will not work for occurrences in other contexts. For instance, this representation would not be appropriate for a renaming of the implicitly declared inequality operator, or for an implicitly declared operator that is used as a generic actual parameter.

In order for used occurrences (used_name_id nodes) to have a defining occurrence to reference, the implicitly declared inequality operator is represented by an operator_id. Unfortunately, this operator does not have a header or a body to be referenced by the attributes of the operator_id; some indication that this operator is a special case is needed. Thus the implicit_not_eq node was defined. Instead of referencing a body, the as unit desc attribute of an operator_id corresponding to an implicitly declared inequality operator denotes an implicit_not_eq node, which provides access to the body of the corresponding equality operator. The as header attribute of the operator_id designates either the header of the corresponding equality operator, or a copy of it.

4.7.5 DERIVED SUBPROGRAMS

A derived type definition introduces a derived subprogram for each subprogram that is an operation of the parent type (i.e. each subprogram having either a parameter or a result of the parent type) and is derivable. A subprogram that is an operation of a parent type is derivable if both the parent type and the subprogram itself are declared immediately within the visible part of the same package (the subprogram must be explicitly declared, and becomes derivable at the end of the visible part). If the parent type is also a derived type, and it has derived subprograms, then those derived subprograms are also derivable.

The derived subprogram has the same designator as the corresponding derivable subprogram; however, it does not have the same parameter and result type profile. It should be noted that it would be possible to perform semantic checking without an explicit representation of the derived subprogram. All used occurrences of the designator could reference the defining occurrence of the corresponding derivable subprogram. When processing a subprogram call with that designator, the parameter and result type profile of the derivable subprogram could be checked. If the profile of the derivable subprogram was not appropriate, and a derived type was involved, then a check could be made to see if the subprogram was derivable for that particular type (i.e. that a derived subprogram does exist).

Unfortunately, the circumstances under which a derived subprogram is created are complex; it would be very difficult and inefficient to repeatedly calculate whether or not a derived subprogram existed. Hence derived subprograms are explicitly represented in DIANA. The appropriate defining occurrence node is created, and the sm unit desc attribute denotes a derived subprog node, thereby distinguishing the derived subprogram from other kinds of subprograms. Once the new specification has been created, the derived subprogram can be treated as any other subprogram is treated; it is no longer a special case.

The specification of the derived subprogram is a copy of that of the derivable subprogram, with substitutions made to compensate for the type changes. As outlined in section 3.4 of the Ada Reference Manual, all references to the parent type are changed to references to the derived type, and any expression of the parent type becomes the operand of a type conversion that has the derived type as the target type. The specification of the derived subprogram deviates from the specification described in the Ada Reference Manual in one respect. The manual states that "any subtype of the parent type is likewise replaced by a subtype of the derived type with a similar constraint" [ARM, 3.4]. If this suggestion were followed, both an anonymous subtype and a new constraint would have to be created. Fortunately, both the requirements for semantic checking and the semantics of calls to the derived subprogram allow a representation which does not require the construction of new nodes (or subtypes).

All references to subtypes of the parent type are changed to references to the derived type in the specification of the derived subprogram. Because semantic checking requires only the base type, this representation provides all of the information needed to perform the checks. A call to a derived subprogram is equivalent to a call to the corresponding derivable subprogram, with

appropriate conversions to the parent type for actual parameters and return values of the derived type. Though the derived subprogram has its own specification, it does not have its own body, thus the type conversions described in section 3.4 of the Ada Reference Manual are necessary. In addition to performing the required type conversions to the parent type, an implementation could easily perform conversions to subtypes of the parent type when appropriate, thereby eliminating the need to create an anonymous subtype of the derived type. The `derived_subprog` node provides access to the defining occurrence of the corresponding derivable subprogram (and hence to the types and subtypes of its formal parameters).

Although the defining occurrence of a derived subprogram is represented in DIANA, its declaration is not, even though the Ada Reference Manual states that the implicit declaration of the derived subprogram follows the declarations of the operations of the derived type (which follow the derived type declaration itself). Consequently the defining occurrence of a derived subprogram can be referenced by semantic attributes alone.

Section 4.8

PRAGMAS

4.8 PRAGMAS

The Ada programming language allows pragmas to occur in numerous places, most of which may be in sequences (sequences of statements, declarations, variants, etc.). To take advantage of this fact, several DIANA classes have been expanded to allow pragmas -- in particular, those classes which are used as sequence element types and which denote syntactic constructs marking places at which a pragma may appear. For instance, the class STM_ELEM contains the node `stm_pragma` and the class STM. All constructs which are defined as sequences of statements in the Ada syntax are represented in DIANA by a sequence containing nodes of type STM_ELEM.

The approach taken for the representation of comments could have been applied to pragmas; i.e. adding an attribute by which pragmas could be attached to each node denoting a construct that could be adjacent to a pragma. This approach has two disadvantages: there is a need to decide if a pragma should be associated with the construct preceding it or the one following it; and the attribute is "wasted" when a pragma is not adjacent to the node (which will be the most common case). Since the set of classes needing expansion is a small subset of the DIANA classes, it was decided to allow the nodes representing pragmas to appear directly in the associated sequences, exactly as given in the source.

The `pragma` node could not be added directly to each class needing it without introducing multiple membership for the `pragma` node. Since the DIANA classes are arranged in a hierarchy (if one excludes class the node `void`) such a situation would be highly undesirable. Instead, the `pragma` node is included in class `USE_PRAGMA`, which is contained in class `DECL`, and an intermediate node is included in the other classes. This intermediate node has an as pragma attribute denoting the actual `pragma` node. The `stm_pragma` node mentioned at the beginning of this section is an intermediate node.

Sequences of the following constructs may contain pragmas:

- (a) declarations (`decl_s` and `item_s`)
- (b) statements (`stm_s`)
- (c) variants (`variant_s`)
- (d) select alternatives (`test_clause_elem_s`)

- (e) case statement alternatives (alternative_s)
- (f) component clauses (comp_rep_s)
- (g) context clauses (context_elem_s)
- (h) use clauses (use_pragma_s)

Unfortunately pragmas do not ALWAYS appear in sequences. In a few cases it was necessary to add an as pragma_s attribute to nodes representing portions of source code which can contain pragmas. These cases are discussed in the following paragraphs.

The comp_list node (which corresponds to a component list in a record type definition) has an as pragma_s attribute to represent the pragmas occurring between the variant part and the end of the record type definition (i.e. between the "end case" and the "end record").

The labeled node, which represents a labeled statement, has an as pragma_s attribute to denote the pragmas appearing between the label or labels and the statement itself.

Pragmas may occur before an alignment clause in a record representation clause (i.e. between the "use record" and the "at mod"), hence the alignment_clause node also has an as pragma_s attribute. If a record representation clause does not have an alignment clause then a pragma occurring after the reserved words "use record" is represented by an intermediate comp_rep_pragma node in the comp_rep_s sequence (in this case the comp_rep_s sequence will have to be constructed whether any component clauses exist or not).

Finally, the compilation_unit node defines an as pragma_s attribute which denotes a non-empty sequence in one of two cases. A compilation may consist of pragmas alone, in which case the as pragma_s denotes the pragmas given for the compilation, and the other attributes are empty sequences or void.

If the compilation contains a compilation unit then as pragma_s represents the pragmas which follow the compilation unit and are not associated with the following compilation unit (if there is a compilation unit following it at all). INLINE and INTERFACE pragmas occurring between compilation units must be associated with the preceding compilation unit according to the rules of the Ada programming language. LIST and PAGE pragmas may be associated with either unit unless they precede or follow a pragma which forces an association (i.e. a LIST pragma preceding an INLINE pragma must be associated with the previous compilation unit, since pragmas in DIANA must appear in the order given, and the INLINE pragma belongs with the previous unit). These four pragmas are the only ones which may follow a compilation unit.

Certain pragmas may be applied to specific entities. Although the presence of these pragmas must be recorded as they occur in the source (to enable the source to be constructed), it would be convenient if the information that they conveyed were readily available during semantic processing of the associated entity. Hence DIANA defines additional attributes to record pertinent pragma

information in the nodes representing defining occurrences of certain entities to which pragmas may be applied. The following pragmas have corresponding semantic attributes:

- (a) CONTROLLED
sm is controlled in the access node
- (b) INLINE
sm is inline in the generic_id and SUBPROG_NAME nodes
- (c) INTERFACE
sm interface in the SUBPROG_NAME nodes
- (d) PACK
sm is packed in the UNCONSTRAINED_COMPOSITE nodes
- (e) SHARED
sm is shared in the variable_id node

Although it may seem that the pragmas OPTIMIZE, PRIORITY, and SUPPRESS should also have associated attributes, they do not. Each of these pragmas applies to the enclosing block or unit. The information conveyed by the OPTIMIZE and PRIORITY pragmas could easily be incorporated into the DIANA as it is read in. The SUPPRESS pragma is more complicated -- not only is a particular constraint check specified, but the name of a particular entity may be given as well. SUPPRESS is too dependent upon the constraint checking mechanism of an implementation to be completely specified by DIANA; in fact, the omission of the constraint checks is optional.

CHAPTER 5

EXAMPLES

This chapter consists of examples of DIANA structures. Each example contains a segment of Ada source code and an illustration of the resulting DIANA structure. Each node is represented by a box, with its type appearing in the upper left-hand corner. Structural attributes are represented as labeled arcs which connect the nodes. All other kinds of attributes appear inside the node itself; code and semantic attributes are represented by a name and a value, while lexical attributes representing names or numbers appear as strings (inside of quotes). All sequences are depicted as having a header node, even if the sequence is empty. If the copying of a node is optional, it is NOT copied in these examples.

These illustrations DO NOT imply that all DIANA representations of these particular Ada code segments must consist of the same combination of nodes and arcs. For instance, an implementation is not required to have a header node for a sequence. The format for these examples was selected because it seemed to be the most straightforward and easy to understand.

In certain instances an arc may point to a short text sequence describing the node that is referenced rather than pointing to the node itself. This is done for any of the following reasons:

- o the node is pictured in an example on another page
- o the node is not pictured in any of the examples
- o the node represents a predefined entity which cannot be depicted because it is implementation-dependent
- o the node is on the same page, but pointing to it would cause arcs to cross and result in a picture that would be difficult to understand

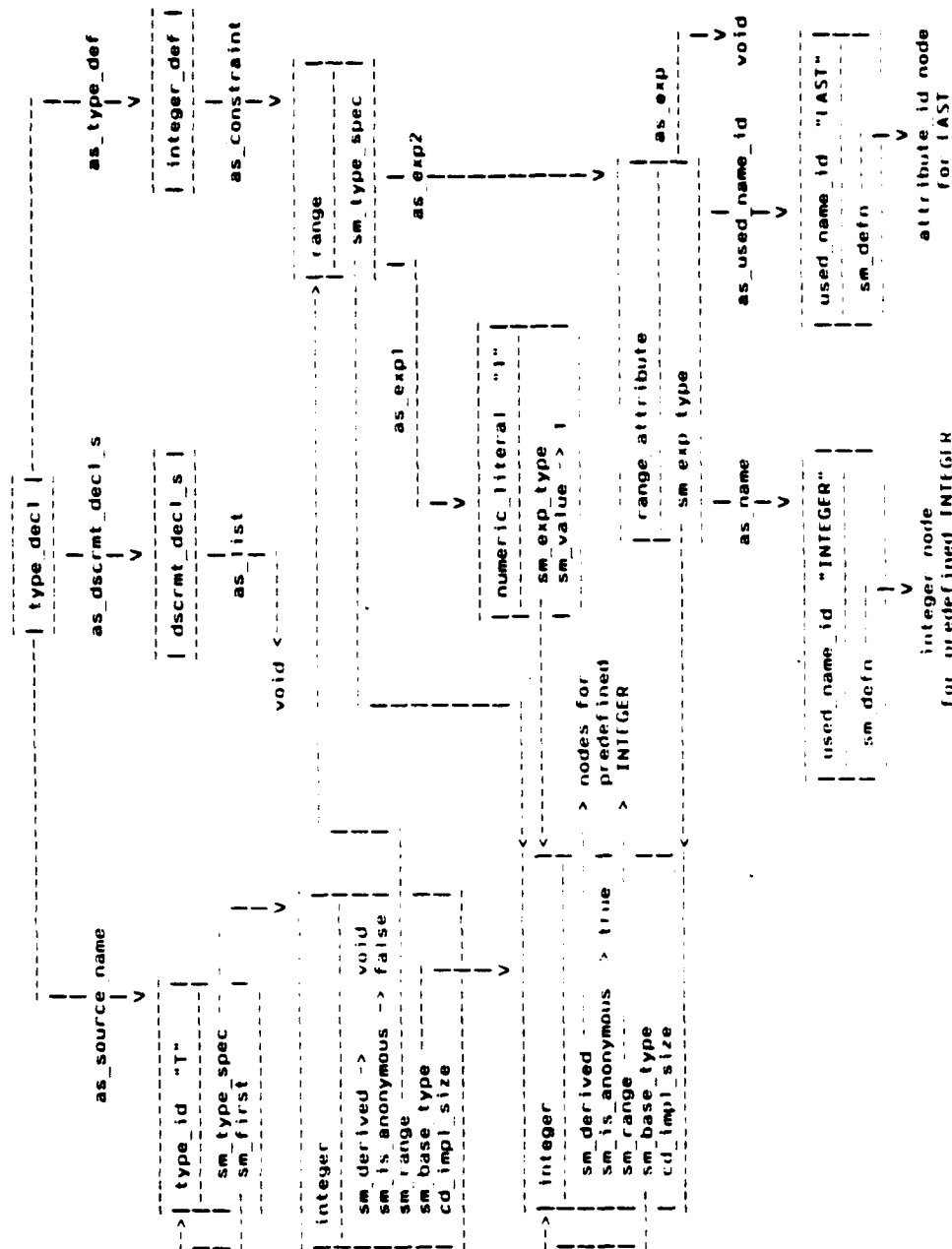
LIST OF EXAMPLES

- 1 - Enumeration Type Definition
- 2 - Integer Type Definition
- 3a - Subtype Declaration
- 3b - Multiple Object Declaration
- 3c - Multiple Object Declaration with Anonymous Subtype
- 4a - Private Type Declaration
- 4b - Full Record Type Declaration
- 4c - Declarations of Subtype of Private Type
- 5a - Generic Procedure Declaration
- 5b - Generic Instantiation
- 6a - Array Type Definition
- 6b - Object Declaration with Anonymous Array Subtype
- 6c - Assignment of an Array Aggregate

[illegible]

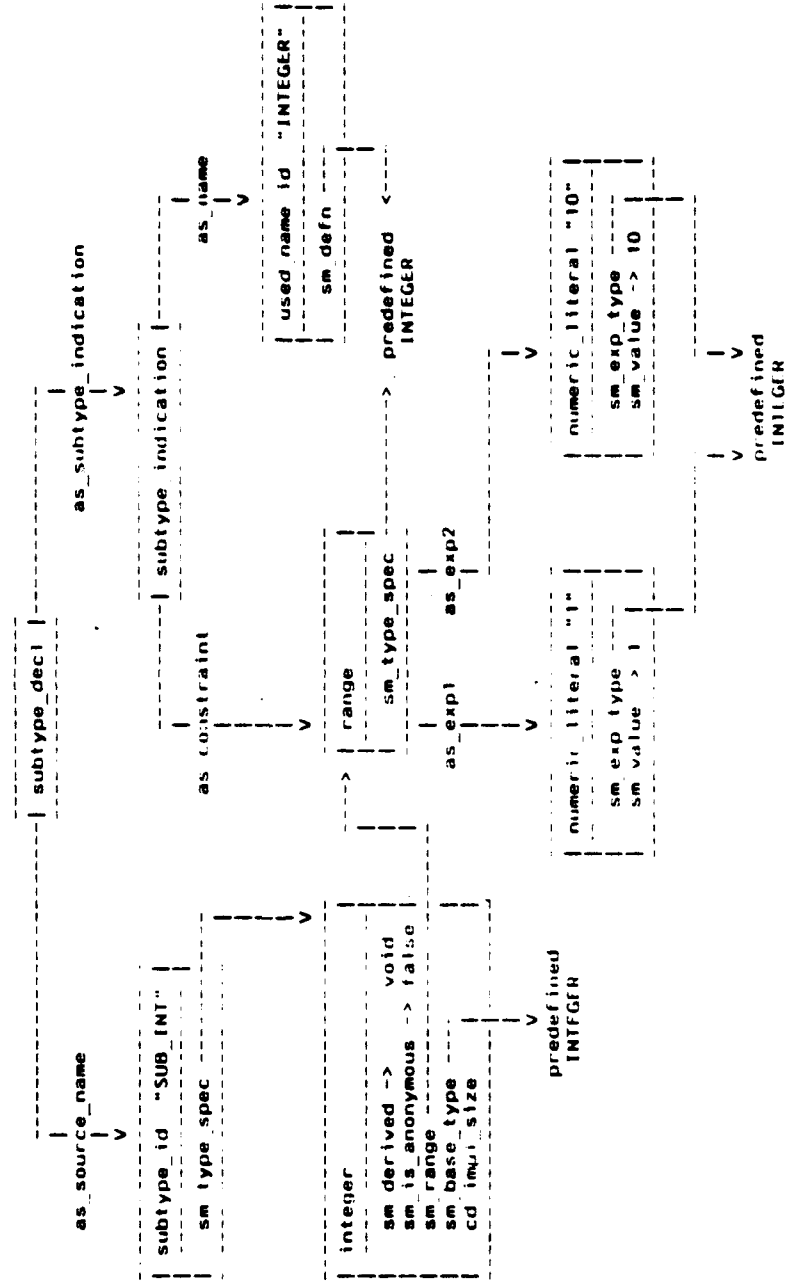
Example	Enumeration	Type	Definition
---------	-------------	------	------------

type T is range 1 .. INTEGER ' LAST;



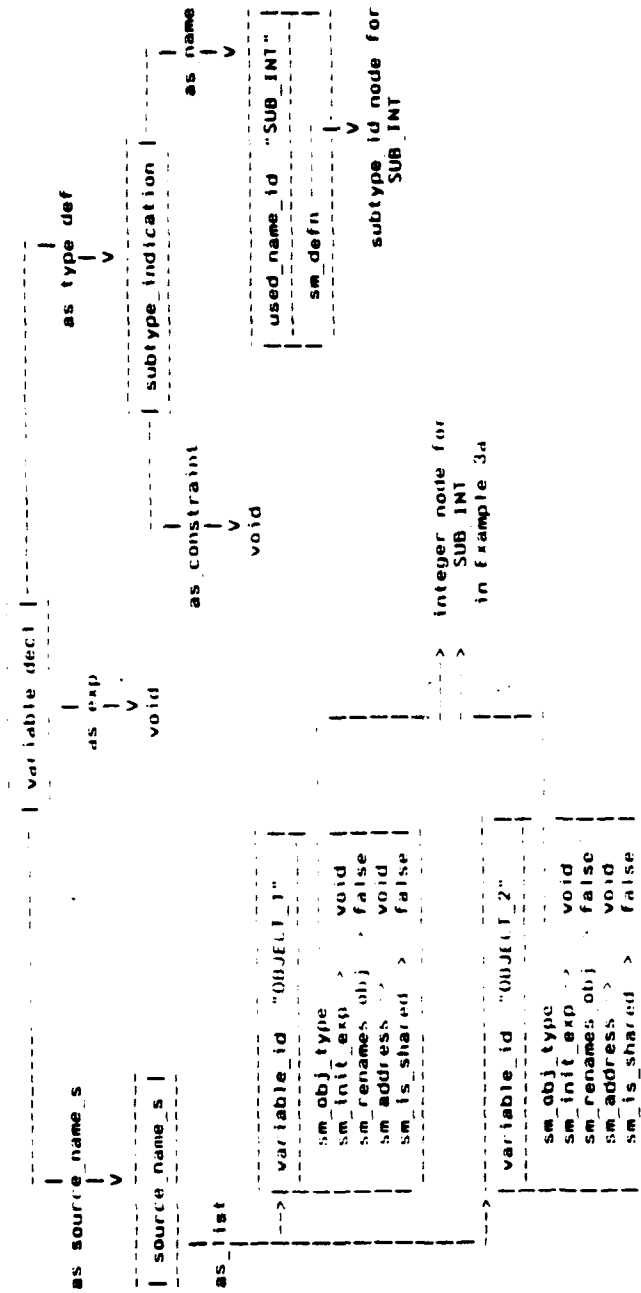
Example 2 Integer Type Definition

subtype SUB_INT is INTEGER range 1..10;



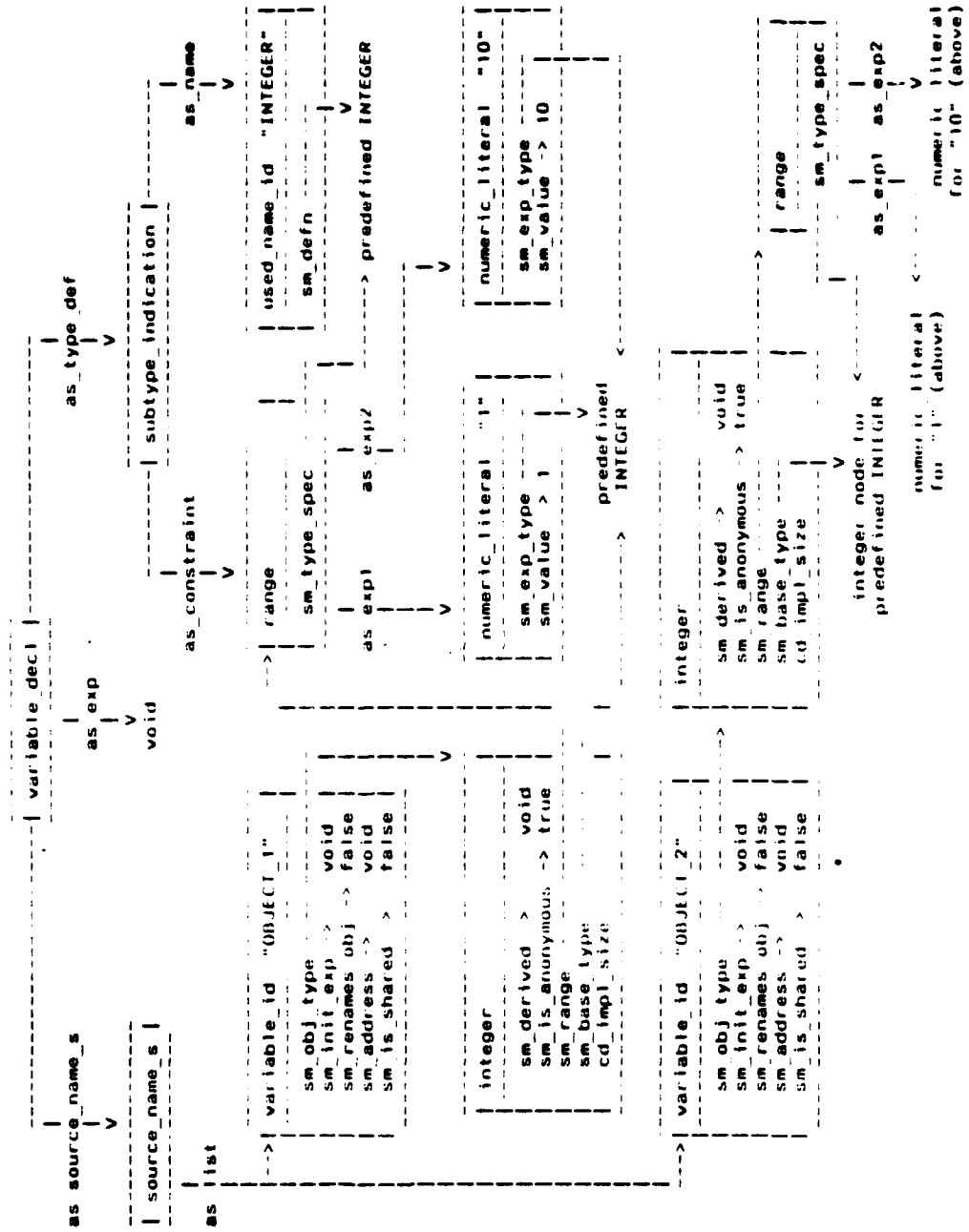
Example 3a Subtype Declaration

OBJECT 1, OBJECT 2 : SUB_INT;



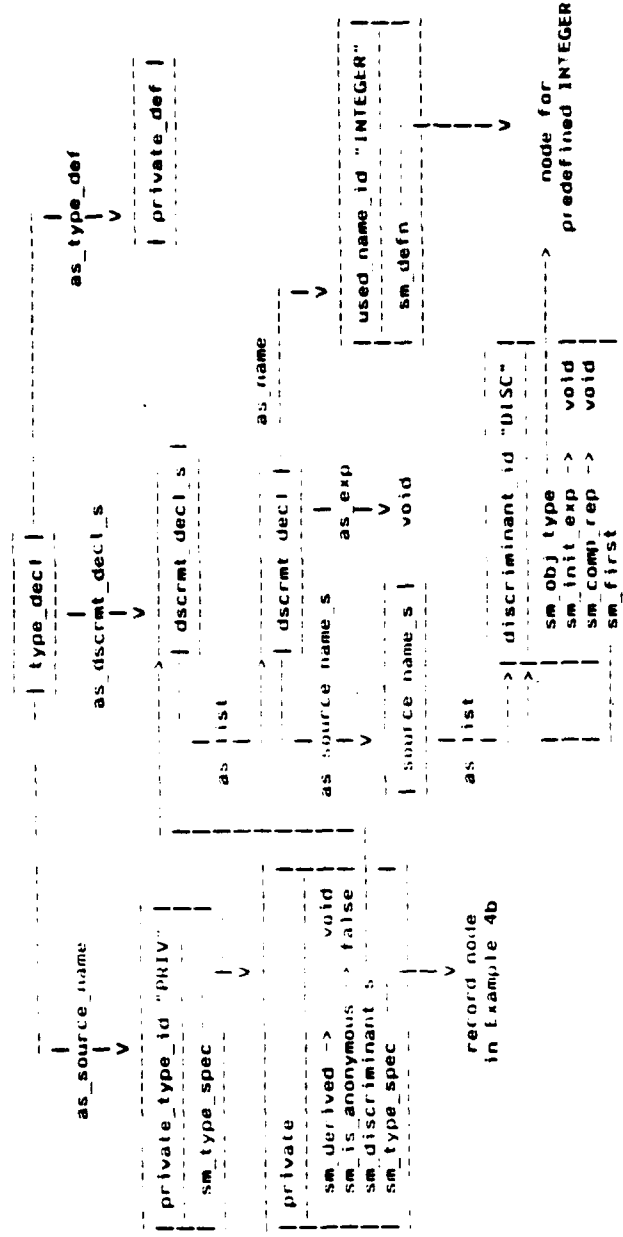
Example 3b Multiple Object Declaration

OBJECT 1, OBJECT 2 : INTEGER range 1 .. 10;



Example 3: Multiple Object Declaration with Anonymous Subtype

type PRIV (DISC : INTEGER) is private;



Example 4a - Private Type Declaration

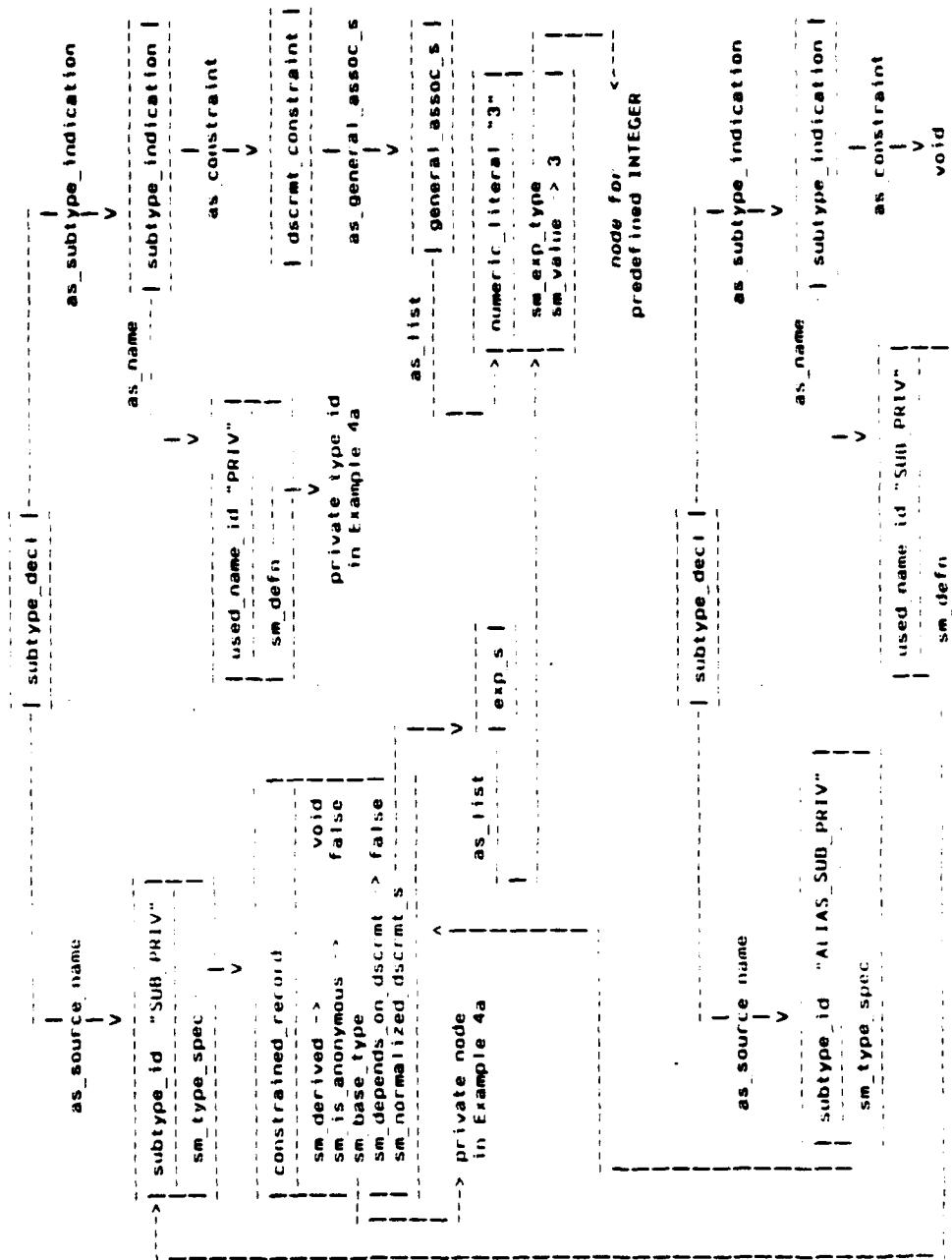
[illegible]

Example 4b - full Record Type Declaration

```

subtype SUB_PRIV is PRIV ( 3 );
subtype ALIAS_SUB_PRIV is SUB_PRIV;

```



Example 4c: Declarations of Subtype of Private type

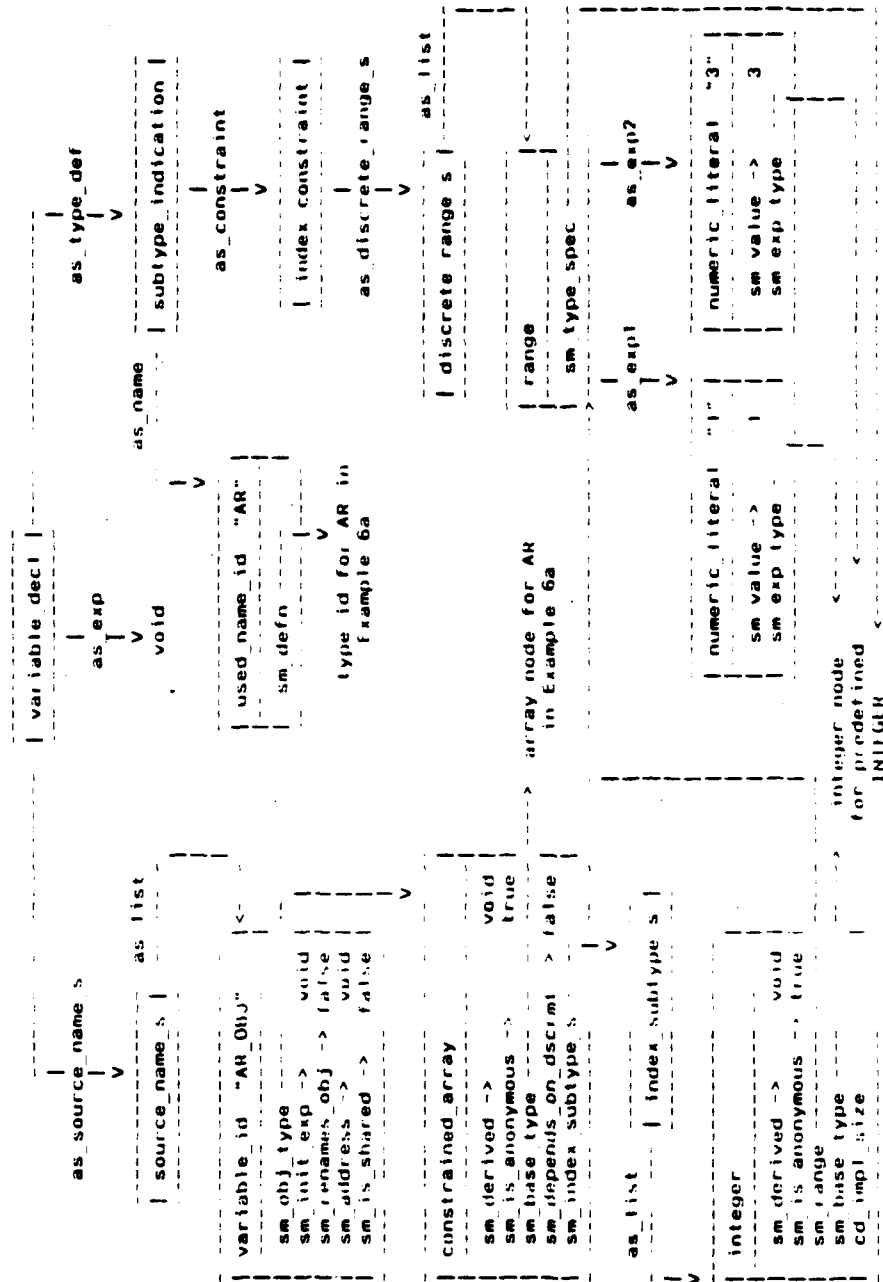

```

      | type decl |
      | as source name |
      | as type def |
      | as discrnt decl s |
      | as subtype indication |
      | unconstrained array def |
      | as subtype indication |
      | subtype indication |
      | as name |
      | as constraint |
      | used name id "INTEGER" |
      | sm defn |
      | integer node for < predefined INTEGER |
      | type id node for predefined INTEGER |

```

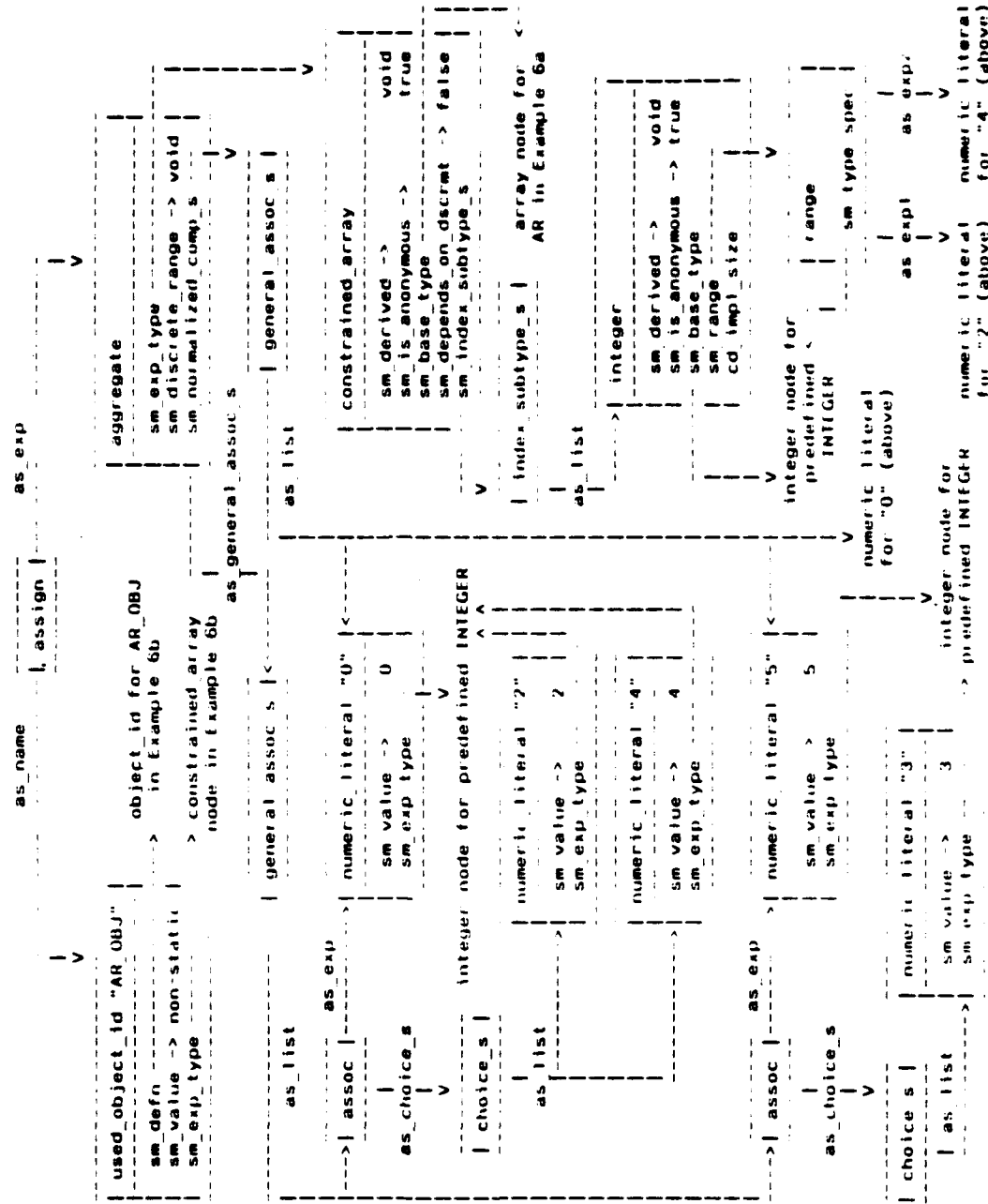
{ sample b.)	Array Type Definition
---------------------	------------------------------

AR_OBJ : AR (1 .. 3);



Example 6b Object Declaration with Anonymous Array Subtype

AR_OBJ := (2 | 4 => 0, 3 => 5);



Example 6c Assignment of an Array Aggregate

CHAPTER 6
EXTERNAL REPRESENTATION OF DIANA

The contents of this chapter will be included at a later date.

CHAPTER 7
THE DIANA PACKAGE IN ADA

The contents of this chapter will be included at a later date.

APPENDIX A
DIANA CROSS-REFERENCE GUIDE

PARTITIONS : 2
STRICT CLASSES : 94
STRICT CLASSES NOT DEFINING ATTRIBUTES : 35
STRICT CLASSES THAT DO NOT SERVE AS TYPES : 55
STRICT CLASSES THAT DO NOT SERVE AS TYPES
AND DO NOT DEFINE ATTRIBUTES : 3
LEAF NODES : 207
LEAF NODES NOT DEFINING ATTRIBUTES : 92
ATTRIBUTES : 135

PARTITIONS (UNINCLUDED CLASSES)

ALL_SOURCE
TYPE_SPEC

STRICT CLASSES THAT DO NOT SERVE AS TYPES AND DO NOT DEFINE ATTRIBUTES

FULL_TYPE_SPEC
GENERIC_PARAM
SEQUENCES

STRICT CLASSES THAT DO NOT DEFINE ATTRIBUTES

ALIGNMENT_CLAUSE
ALL_DECL
ALTERNATIVE_ELEM
BODY
CHOICE
COMP_REP_ELEM
CONSTRAINT
CONTEXT_ELEM
DECL
DISCRETE_RANGE
EXP
FULL_TYPE_SPEC
GENERAL_ASSOC
GENERIC_PARAM
HEADER
ITEM
ITERATION
MEMBERSHIP_OP
NAME
PARAM
PREDEF_NAME
SEQUENCES
SHORT_CIRCUIT_OP
SOURCE_NAME
STM
STM_ELEM
TEST_CLAUSE_ELEM
TYPE_DEF
TYPE_SPEC
UNIT_DESC
UNIT_KIND
USE_PRAGMA
USED_NAME
VARIANT_ELEM
VARIANT_PART

STRICT CLASSES THAT DO NOT SERVE AS TYPES

AGG_EXP	UNCONSTRAINED
ALL_SOURCE	UNCONSTRAINED_COMPOSITE
ARR_ACC_DER_DEF	UNIT_DECL
BLOCK_LOOP	UNIT_NAME
CALL_STM	USED_OBJECT
CLAUSES_STM	VC_NAME
COMP_NAME	
CONSTRAINED	
CONSTRAINED_DEF	
DERIVABLE_SPEC	
OSCRMT_PARAM_DECL	
ENTRY_STM	
EXP_DECL	
EXP_EXP	
EXP_VAL	
EXP_VAL_EXP	
FOR_REV	
FULL_TYPE_SPEC	
GENERIC_PARAM	
ID_DECL	
ID_S_DECL	
INIT_OBJECT_NAME	
LABEL_NAME	
MEMBERSHIP	
NAME_EXP	
NAME_VAL	
NAMED_ASSOC	
NAMED_REP	
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NON_TASK	
NON_TASK_NAME	
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OBJECT_NAME	
PARAM_NAME	
PRIVATE_SPEC	
QUAL_CONV	
REAL	
REAL_CONSTRAINT	
RENAME_INSTANT	
SEQUENCES	
SIMPLE_RENAME_DECL	
STM_WITH_EXP	
STM_WITH_EXP_NAME	
STM_WITH_NAME	
SUBP_ENTRY_HEADER	
SUBPROG_NAME	
SUBPROG_PACK_NAME	
TEST_CLAUSE	
TYPE_NAME	

LEAF NODES (CLASSES WITHOUT MEMBERS)

abort	decl_s
accept	deferred_constant_decl
access	delay
access_def	derived_def
address	derived_subprog
aggregate	discrete_range_s
alignment	discrete_subtype
all	discriminant_id
alternative	dscrm_t_constraint
alternative_pragma	dscrm_t_decl
alternative_s	dscrm_t_decl_s
and_then	entry
argument_id	entry_call
argument_id_s	entry_id
array	enum_literal_s
assign	enumeration
assoc	enumeration_def
attribute	enumeration_id
attribute_id	exception_decl
block	exception_id
block_body	exit
block_loop_id	exp_s
block_master	fixed
bltn_operator_id	fixed_constraint
box_default	fixed_def
case	float
character_id	float_constraint
choice_exp	float_def
choice_others	for
choice_range	formal_dscrt_def
choice_s	formal_fixed_def
code	formal_float_def
comp_list	formal_integer_def
comp_rep	function_call
comp_rep_pragma	function_id
comp_rep_s	function_spec
compilation	general_assoc_s
compilation_unit	generic_decl
compltn_unit_s	generic_id
component_id	goto
cond_clause	if
cond_entry	implicit_not_eq
constant_decl	in
constant_id	in_id
constrained_access	in_op
constrained_array	in_out
constrained_array_def	in_out_id
constrained_record	incomplete
context_elem_s	index
context_pragma	index_constraint
conversion	index_s

indexed	renames_unit
instantiation	return
integer	reverse
integer_def	scalar_s
item_s	select_alt_pragma
iteration_id	select_alternative
l_private	selected
l_private_def	selective_wait
l_private_type_id	short_circuit
label_id	slice
labeled	source_name_s
length_enum_rep	stm_pragma
loop	stm_s
name_default	string_literal
name_s	stub
named	subprog_entry_decl
no_default	subprogram_body
not_in	subtype_allocator
null_access	subtype_decl
null_comp_decl	subtype_id
null_stm	subtype_indication
number_decl	subunit
number_id	task_body
numeric_literal	task_body_id
operator_id	task_decl
or_else	task_spec
out	terminate
out_id	test_clause_elem_s
package_body	timed_entry
package_decl	type_decl
package_id	type_id
package_spec	type_membership
param_s	unconstrained_array_def
parenthesized	universal_fixed
pragma	universal_integer
pragma_id	universal_real
pragma_s	use
private	use_pragma_s
private_def	used_char
private_type_id	used_name_id
procedure_call	used_object_id
procedure_id	used_op
procedure_spec	variable_decl
qualified	variable_id
qualified_allocator	variant
raise	variant_part
range	variant_pragma
range_attribute	variant_s
range_membership	void
record	while
record_def	with
record_rep	
renames_exc_decl	
renames_obj_decl	

LEAF NODES THAT DO NOT DEFINE ATTRIBUTES

access_def	null_comp_decl
address	null_stm
all	number_decl
and_then	number_id
argument_id	operator_id
assign	or_else
attribute_id	out
block_loop_id	out_id
box_default	package_body
character_id	package_decl
choice_others	package_id
code	parenthesized
component_id	private
cond_clause	private_def
cond_entry	private_type_id
constant_decl	procedure_call
conversion	procedure_id
delay	procedure_spec
derived_def	qualified
dscrmt_decl	raise
entry_call	renames_exc_decl
enumeration_id	renames_unit
exception_decl	return
fixed_constraint	reverse
fixed_def	select_alternative
float	selective_wait
float_constraint	stub
float_def	subprog_entry_decl
for	subtype_id
formal_dscrt_def	task_body
formal_fixed_def	terminate
formal_float_def	timed_entry
formal_integer_def	universal_fixed
function_id	universal_integer
goto	universal_real
if	used_char
in_id	used_name_id
in_op	used_object_id
in_out	used_op
in_out_id	variable_decl
integer	void
integer_def	
iteration_id	
l_private	
l_private_def	
l_private_type_id	
label_id	
length_enum_rep	
no_default	
not_in	
null_access	

PREDEFINED AND USER-DEFINED TYPES

source_position IS THE DECLARED TYPE OF:

ALL_SOURCE.lx_srcpos

comments IS THE DECLARED TYPE OF:

ALL_SOURCE.lx_comments

symbol_rep IS THE DECLARED TYPE OF:

DEF_NAME.lx_symrep

DESIGNATOR.lx_symrep

string_literal.lx_symrep

value IS THE DECLARED TYPE OF:

fixed.cd_impl_small

REAL.sm_accuracy

EXP_VAL.sm_value

NAME_VAL.sm_value

USED_OBJECT.sm_value

operator IS THE DECLARED TYPE OF:

bltn_operator_id.sm_operator

number_rep IS THE DECLARED TYPE OF:

numeric_literal.lx_numrep

Boolean IS THE DECLARED TYPE OF:

- in.lx_default
- function_call.lx_prefix
- CONSTRAINED.sm_depends_on_dscrmt
- DERIVABLE_SPEC.sm_is_anonymous
- access.sm_is_controlled
- generic_id.sm_is_inline
- SUBPROG_NAME.sm_is_inline
- UNCONSTRAINED_COMPOSITE.sm_is_limited
- UNCONSTRAINED_COMPOSITE.sm_is_packed
- variable_id.sm_is_shared
- VC_NAME.sm_renames_obj

Integer IS THE DECLARED TYPE OF:

- SCALAR.cd_impl_size
- ENUM_LITERAL.sm_pos
- ENUM_LITERAL.sm_rep

ATTRIBUTES

as_alignment_clause : ALIGNMENT_CLAUSE
 <= record_rep

as_all_decl : ALL_DECL
 <= compilation_unit

as_alternative_s : alternative_s
 <= block_body
 <= case

as_block_body : block_body
 <= block

as_body : BODY
 <= SUBUNIT_BODY

as_choice_s : choice_s
 <= alternative
 <= named
 <= variant

as_comp_list : comp_list
 <= record_def
 <= variant

as_comp_rep_s : comp_rep_s
 <= record_rep

as_compltn_unit_s : compltn_unit_s
 <= compilation

as_constraint : CONSTRAINT
 <= constrained_array_def
 <= CONSTRAINED_DEF

as_context_elem_s : context_elem_s
 <= compilation_unit

as_decl_s : decl_s
 <= comp_list
 <= task_decl

as_decl_s1 : decl_s
 <= package_spec

as_decl_s2 : decl_s
 <= package_spec

as_designator : DESIGNATOR
 <= selected

```

as_discrete_range      : DISCRETE_RANGE
    <= choice_range
    <= entry
    <= FOR_REV
    <= slice

as_discrete_range_s    : discrete_range_s
    <= index_constraint

as_dscrmt_decl_s       : dscrmt_decl_s
    <= type_decl

as_enum_literal_s      : enum_literal_s
    <= enumeration_def

as_exp                 : EXP
    <= alignment
    <= attribute
    <= choice_exp
    <= comp_rep
    <= DSCRMT_PARAM_DECL
    <= EXP_DECL
    <= EXP_VAL_EXP
    <= NAMED_ASSOC
    <= NAMED_REP
    <= range_attribute
    <= REAL_CONSTRAINT
    <= STM_WITH_EXP
    <= TEST_CLAUSE
    <= while

as_exp1                : EXP
    <= range
    <= short_circuit

as_exp2                : EXP
    <= range
    <= short_circuit

as_exp_s               : exp_s
    <= indexed

as_general_assoc_s     : general_assoc_s
    <= aggregate
    <= CALL_STM
    <= dscrmt_constraint
    <= function_call
    <= instantiation
    <= pragma

as_header              : HEADER
    <= subprogram_body
    <= UNIT_DECL
  
```

as_index_s	: index_s
<= unconstrained_array_def	
as_item_s	: item_s
<= block_body	
<= generic_decl	
as_iteration	: ITERATION
<= loop	
as_list	: Seq Of GENERAL_ASSOC
<= general_assoc_s	
as_list	: Seq Of SOURCE_NAME
<= source_name_s	
as_list	: Seq Of ENUM_LITERAL
<= enum_literal_s	
as_list	: Seq Of DISCRETE_RANGE
<= discrete_range_s	
as_list	: Seq Of SCALAR
<= scalar_s	
as_list	: Seq Of index
<= index_s	
as_list	: Seq Of dscrmt_decl
<= dscrmt_decl_s	
as_list	: Seq Of VARIANT_ELEM
<= variant_s	
as_list	: Seq Of CHOICE
<= choice_s	
as_list	: Seq Of ITEM
<= item_s	
as_list	: Seq Of EXP
<= exp_s	
as_list	: Seq Of STM_ELEM
<= stm_s	
as_list	: Seq Of ALTERNATIVE_ELEM
<= alternative_s	
as_list	: Seq Of PARAM
<= param_s	
as_list	: Seq Of DECL
<= decl_s	

as_list : Seq Of TEST_CLAUSE_ELEM
 <= test_clause_elem_s

as_list : Seq Of NAME
 <= name_s

as_list : Seq Of compilation_unit
 <= compltn_unit_s

as_list : Seq Of pragma
 <= pragma_s

as_list : Seq Of CONTEXT_ELEM
 <= context_elem_s

as_list : Seq Of USE_PRAGMA
 <= use_pragma_s

as_list : Seq Of COMP_REP_ELEM
 <= comp_rep_s

as_list : Seq Of argument_id
 <= argument_id_s

as_membership_op : MEMBERSHIP_OP
 <= MEMBERSHIP

as_name : NAME
 <= accept
 <= comp_rep
 <= deferred_constant_decl
 <= DSCRMT_PARAM_DECL
 <= function_spec
 <= index
 <= name_default
 <= NAME_EXP
 <= QUAL_CONV
 <= range_attribute
 <= RENAME_INSTANT
 <= REP
 <= SIMPLE_RENAME_DECL
 <= STM_WITH_EXP_NAME
 <= STM_WITH_NAME
 <= subtype_indication
 <= subunit
 <= type_membership
 <= variant_part

as_name_s : name_s
 <= abort
 <= use
 <= with

```
as_param_s          : param_s
    <= accept
    <= SUBP_ENTRY_HEADER

as_pragma            : pragma
    <= alternative_pragma
    <= comp_rep_pragma
    <= context_pragma
    <= select_alt_pragma
    <= stm_pragma
    <= variant_pragma

as_pragma_s          : pragma_s
    <= alignment
    <= comp_list
    <= compilation_unit
    <= labeled

as_qualified         : qualified
    <= qualified_allocator

as_range             : RANGE
    <= comp_rep
    <= range_membership
    <= REAL_CONSTRAINT

as_short_circuit_op  : SHORT_CIRCUIT_OP
    <= short_circuit

as_source_name       : SOURCE_NAME
    <= BLOCK_LOOP
    <= FOR_REV
    <= ID_DECL
    <= SUBUNIT_BODY

as_source_name_s     : source_name_s
    <= DSCRMT_PARAM_DECL
    <= ID_S_DECL
    <= labeled

as_stm               : STM
    <= labeled

as_stm_s             : stm_s
    <= accept
    <= alternative
    <= block_body
    <= CLAUSES_STM
    <= loop
    <= TEST_CLAUSE

as_stm_sl            : stm_s
    <= ENTRY_STM
```

```
as_stm_s2           : stm_s
  <= ENTRY_STM

as_subtype_indication : subtype_indication
  <= ARR_ACC_DER_DEF
  <= discrete_subtype
  <= subtype_allocator
  <= subtype_decl

as_subunit_body      : SUBUNIT_BODY
  <= subunit

as_test_clause_elem_s : test_clause_elem_s
  <= CLAUSES_STM

as_type_def           : TYPE_DEF
  <= OBJECT_DECL
  <= type_decl

as_type_mark_name     : NAME
  <= renames_obj_decl

as_unit_kind           : UNIT_KIND
  <= NON_GENERIC_DECL

as_use_pragma_s       : use_pragma_s
  <= with

as_used_name           : USED_NAME
  <= assoc

as_used_name_id        : used_name_id
  <= attribute
  <= pragma
  <= range_attribute

as_variant_part        : VARIANT_PART
  <= comp_list

as_variant_s           : variant_s
  <= variant_part

cd_impl_size           : Integer
  <= SCALAR

cd_impl_small          : value
  <= fixed

lx_comments            : comments
  <= ALL_SOURCE

lx_default             : Boolean
  <= in
```

lx_numrep	:	number_rep
<= numeric_literal		
lx_prefix	:	Boolean
<= function_call		
lx_srcpos	:	source_position
<= ALL_SOURCE		
lx_symrep	:	symbol_rep
<= DEF_NAME		
<= DESIGNATOR		
<= string_literal		
sm_accuracy	:	value
<= REAL		
sm_address	:	EXP
<= entry_id		
<= SUBPRG_PACK_NAME		
<= task_spec		
<= VC_NAME		
sm_argument_id_s	:	argument_id_s
<= pragma_id		
sm_base_type	:	TYPE_SPEC
<= NON_TASK		
sm_body	:	BODY
<= generic_id		
<= task_body_id		
<= task_spec		
sm_comp_list	:	comp_list
<= record		
sm_comp_rep	:	COMP_REP_ELEM
<= COMP_NAME		
sm_comp_type	:	TYPE_SPEC
<= array		
sm_decl_s	:	decl_s
<= instantiation		
<= task_spec		
sm_defn	:	DEF_NAME
<= DESIGNATOR		
sm_depends_on_dscrmt	:	Boolean
<= CONSTRAINED		
sm_derivable	:	SOURCE_NAME

```
<= derived_subprog

sm_derived          : TYPE_SPEC
  <= DERIVABLE_SPEC

sm_desig_type       : TYPE_SPEC
  <= access
  <= constrained_access
  <= subtype_allocator

sm_discrete_range   : DISCRETE_RANGE
  <= AGG_EXP

sm_discriminant_s   : dscrmt_decl_s
  <= incomplete
  <= PRIVATE_SPEC
  <= record

sm_equal            : SOURCE_NAME
  <= implicit_not_eq

sm_exp_type         : TYPE_SPEC
  <= EXP_EXP
  <= NAME_EXP
  <= USED_OBJECT

sm_first            : DEF_NAME
  <= constant_id
  <= discriminant_id
  <= PARAM_NAME
  <= type_id
  <= UNIT_NAME

sm_generic_param_s   : item_s
  <= generic_id

sm_index_s          : index_s
  <= array

sm_index_subtype_s   : scalar_s
  <= constrained_array

sm_init_exp         : EXP
  <= INIT_OBJECT_NAME

sm_interface        : PREDEF_NAME
  <= SUBPROG_NAME

sm_is_anonymous      : Boolean
  <= DERIVABLE_SPEC

sm_is_controlled     : Boolean
  <= access
```


sm_is_inline	: Boolean
<= generic_id	
<= SUBPROG_NAME	
sm_is_limited	: Boolean
<= UNCONSTRAINED_COMPOSITE	
sm_is_packed	: Boolean
<= UNCONSTRAINED_COMPOSITE	
sm_is_shared	: Boolean
<= variable_id	
sm_literal_s	: enum_literal_s
<= enumeration	
sm_master	: ALL_DECL
<= access	
sm_normalized_comp_s	: general_assoc_s
<= aggregate	
sm_normalized_dscrm_t_s	: exp_s
<= constrained_record	
sm_normalized_param_s	: exp_s
<= CALL_STM	
<= function_call	
sm_obj_type	: TYPE_SPEC
<= OBJECT_NAME	
sm_operator	: operator
<= bltn_operator_id	
sm_pos	: Integer
<= ENUM_LITERAL	
sm_range	: RANGE
<= SCALAR	
sm_renames_exc	: NAME
<= exception_id	
sm_renames_obj	: Boolean
<= VC_NAME	
sm_rep	: Integer
<= ENUM_LITERAL	
sm_representation	: REP
<= record	
sm_size	: EXP

```
<= task_spec
<= UNCONSTRAINED

sm_spec                                : HEADER
    <= entry_id
    <= NON_TASK_NAME

sm_stm                                : STM
    <= block_master
    <= exit
    <= LABEL_NAME

sm_storage_size                       : EXP
    <= access
    <= task_spec

sm_type_spec                          : TYPE_SPEC
    <= index
    <= PRIVATE_SPEC
    <= RANGE
    <= REAL_CONSTRAINT
    <= task_body_id
    <= TYPE_NAME

sm_unit_desc                          : UNIT_DESC
    <= SUBPROG_PACK_NAME

sm_value                              : value
    <= EXP_VAL
    <= NAME_VAL
    <= USED_OBJECT
```

NODES AND CLASSES

** abort

```

IS INCLUDED IN:
    STM
    STM_ELEM
    ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_name_s           : name_s
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos           : source_position
    lx_comments         : comments
  
```

** accept

```

IS INCLUDED IN:
    STM
    STM_ELEM
    ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_name             : NAME
    as_stm_s            : stm_s
    as_param_s          : param_s
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos           : source_position
    lx_comments         : comments
  
```

** access

```

IS INCLUDED IN:
    UNCONSTRAINED
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    sm_storage_size     : EXP
    sm_master            : ALL_DECL
    sm_desig_type       : TYPE_SPEC
    sm_is_controlled     : Boolean
  (INHERITED FROM UNCONSTRAINED):
    sm_size              : EXP
  (INHERITED FROM NON_TASK):
    sm_base_type         : TYPE_SPEC
  (INHERITED FROM DERIVABLE_SPEC):
    sm_derived           : TYPE_SPEC
    sm_is_anonymous      : Boolean
  
```

** access_def

IS INCLUDED IN:
 ARR_ACC_DER_DEF
 TYPE_DEF
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ARR_ACC_DER_DEF):
 as_subtype_indication : subtype_indication
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** address**

IS INCLUDED IN:
 NAMED_REP
 REP
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM NAMED_REP):
 as_exp : EXP
 (INHERITED FROM REP):
 as_name : NAME
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** AGG_EXP**

CLASS MEMBERS:
 aggregate
 string_literal
IS INCLUDED IN:
 EXP_EXP
 EXP
 GENERAL_ASSOC
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 sm_discrete_range : DISCRETE_RANGE
 (INHERITED FROM EXP_EXP):
 sm_exp_type : TYPE_SPEC
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** aggregate**

IS INCLUDED IN:
 AGG_EXP
 EXP_EXP
 EXP

```

    GENERAL_ASSOC
    ALL_SOURCE
  NODE_ATTRIBUTES:
    (NODE_SPECIFIC):
      as_general_assoc_s      : general_assoc_s
      sm_normalized_comp_s    : general_assoc_s
    (INHERITED FROM AGG_EXP):
      sm_discrete_range      : DISCRETE_RANGE
    (INHERITED FROM EXP_EXP):
      sm_exp_type            : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments
  
```

** alignment

```

    IS INCLUDED IN:
      ALIGNMENT_CLAUSE
      ALL_SOURCE
  NODE_ATTRIBUTES:
    (NODE_SPECIFIC):
      as_pragma_s            : pragma_s
      as_exp                 : EXP
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments
  
```

** ALIGNMENT_CLAUSE

```

    CLASS MEMBERS:
      alignment
      void
    IS INCLUDED IN:
      ALL_SOURCE
  NODE_ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments
  IS THE DECLARED TYPE OF:
    record_rep.as_alignment_clause
  
```

** all

```

    IS INCLUDED IN:
      NAME_EXP
      NAME
      EXP
      GENERAL_ASSOC
      ALL_SOURCE
  NODE_ATTRIBUTES:
    (INHERITED FROM NAME_EXP):
      as_name                : NAME
      sm_exp_type            : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
  
```

lx_srcpos	: source_position
lx_comments	: comments

**** ALL_DECL**

CLASS MEMBERS:

block_master
void
ITEM
subunit
DSCRMT_PARAM_DECL
DECL
SUBUNIT_BODY
dscrmt_decl
PARAM
ID_S_DECL
ID_DECL
null_comp_decl
REP
USE_PRAGMA
subprogram_body
task_body
package_body
in
in_out
out
EXP_DECL
deferred_constant_decl
exception_decl
type_decl
UNIT_DECL
task_decl
subtype_decl
SIMPLE_RENAME_DECL
NAMED_REP
record_rep
use
pragma
OBJECT_DECL
number_decl
generic_decl
NON_GENERIC_DECL
renames_obj_decl
renames_exc_decl
length_enum_rep
address
constant_decl
variable_decl
subprog_entry_decl
package_decl

IS INCLUDED IN:

ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

```
lx_srcpos      : source_position
lx_comments    : comments
IS THE DECLARED TYPE OF:
  compilation_unit.as_all_decl
  access.sm_master
```

**** ALL_SOURCE**

CLASS MEMBERS:

```
DEF_NAME
index
compilation_unit
compilation
comp_list
VARIANT PART
ALIGNMENT CLAUSE
VARIANT_ELEM
CONTEXT_ELEM
COMP_REP_ELEM
ALTERNATIVE_ELEM
ITERATION
SHORT_CIRCUIT_OP
MEMBERSHIP_OP
TEST_CLAUSE_ELEM
UNIT_DESC
HEADER
CHOICE
CONSTRAINT
GENERAL_ASSOC
STM_ELEM
SEQUENCES
TYPE_DEF
ALL_DECL
SOURCE_NAME
PREDEF_NAME
variant_part
void
alignment
variant
variant_pragma
context_pragma
with
comp_rep
comp_rep_pragma
alternative
alternative_pragma
FOR REV
while
and_then
or_else
in_op
not_in
TEST_CLAUSE
select_alt_pragma
```

UNIT_KIND
derived_subprog
implicit_not_eq
BODY
SUBP_ENTRY_HEADER
package_spec
choice_exp
choice_others
choice_range
DISCRETE_RANGE
dscrmt_constraint
index_constraint
REAL_CONSTRAINT
NAMED_ASSOC
EXP
STM
stm_pragma
alternative_s
variant_s
use_pragma_s
test_clause_elem_s
stm_s
source_name_s
scalar_s
pragma_s
param_s
name_s
index_s
item_s
exp_s
enum_literal_s
discrete_range_s
general_assoc_s
dscrmt_decl_s
decl_s
context_elem_s
compltn_unit_s
comp_rep_s
choice_s
argument_id_s
enumeration_def
record_def
ARR ACC DER_DEF
CONSTRAINED_DEF
private_def
l_private_def
formal_dscrt_def
formal_float_def
formal_fixed_def
formal_integer_def
block_master
ITEM
subunit
OBJECT_NAME

LABEL_NAME
UNIT_NAME
TYPE_NAME
entry_id
exception_id
attribute_id
bltn_operator_id
argument_id
pragma_id
for
reverse
cond_clause
select_alternative
RENAME_INSTANT
GENERIC_PARAM
block_body
stub
procedure_spec
function_spec
entry
RANGE
discrete_subtype
float_constraint
fixed_constraint
named
assoc
NAME
EXP_EXP
labeled
null_stm
abort
STM_WITH_EXP
STM_WITH_NAME
accept
ENTRY_STM
BLOCK_LOOP
CLAUSES_STM
terminate
constrained_array_def
derived_def
access_def
unconstrained_array_def
subtype_indication
integer_def
fixed_def
float_def
DSCRM_T_PARAM_DECL
DECL
SUBUNIT_BODY
INIT_OBJECT_NAME
ENUM_LITERAL
iteration_id
label_id
block_loop_id

NON_TASK_NAME
task_body_id
type_id
subtype_id
private_type_id
l_private_type_id
renames_unit
instantiation
name_default
no_default
box_default
range
range_attribute
DESIGNATOR
NAME_EXP
EXP_VAL
subtype_allocator
qualified_allocator
AGG_EXP
return
delay
STM_WITH_EXP_NAME
case
goto
raise
CALL_STM
cond_entry
timed_entry
loop
block
if
selective_wait
dscrmt_decl
PARAM
ID_S_DECL
ID_DECL
null_comp_decl
REP
USE_PRAGMA
subprogram_body
task_body
package_body
VC_NAME
number_id
COMP_NAME
PARAM_NAME
enumeration_id
character_id
SUBPROG_PACK_NAME
generic_id
USED_OBJECT
USED_NAME
NAME_VAL
all

slice
indexed
short_circuit
numeric_literal
EXP_VAL_EXP
null_access
aggregate
string_literal
assign
code
exit
entry_call
procedure_call
in
in_out
out
EXP_DECL
deferred_constant_decl
exception_decl
type_decl
UNIT_DECL
task_decl
subtype_decl
SIMPLE_RENAME_DECL
NAMED_REP
record_rep
use
pragma
variable_id
constant_id
component_id
discriminant_id
in_id
out_id
in_out_id
SUBPROG_NAME
package_id
used_char
used_object_id
used_op
used_name_id
attribute
selected
function_call
MEMBERSHIP
QUAL_CONV
parenthesized
OBJECT_DECL
number_decl
generic_decl
NON_GENERIC_DECL
renames_obj_decl
renames_exc_decl
length_enum_rep

address
 procedure_id
 operator_id
 function_id
 range_membership
 type_membership
 conversion
 qualified
 constant_decl
 variable_decl
 subprog_entry_decl
 package_decl

NODE ATTRIBUTES:

(NODE SPECIFIC):

lx_srcpos	: source_position
lx_comments	: comments

** alternative

IS INCLUDED IN:

ALTERNATIVE_ELEM

ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_choice_s	: choice_s
as_stm_s	: stm_s

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

** ALTERNATIVE_ELEM

CLASS MEMBERS:

alternative

alternative_pragma

IS INCLUDED IN:

ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

IS THE DECLARED TYPE OF:

alternative_s.as_list [Seq Of]

** alternative_pragma

IS INCLUDED IN:

ALTERNATIVE_ELEM

ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_pragma	: pragma
-----------	----------

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
-----------	-------------------

lx_comments : comments

**** alternative_s**

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of ALTERNATIVE_ELEM
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 block_body.as_alternative_s
 case.as_alternative_s

**** and_then**

IS INCLUDED IN:
 SHORT_CIRCUIT_OP
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** argument_id**

IS INCLUDED IN:
 PREDEF_NAME
 DEF_NAME
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 argument_id_s.as_list [Seq Of]

**** argument_id_s**

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of argument_id
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:

pragma_id.sm_argument_id_s

**** ARR_ACC_DER_DEF**

CLASS MEMBERS:

constrained_array_def
 derived_def
 access_def
 unconstrained_array_def

IS INCLUDED IN:

TYPE_DEF
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):
 as_subtype_indication : subtype_indication
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** array**

IS INCLUDED IN:

UNCONSTRAINED_COMPOSITE
 UNCONSTRAINED
 NON_TASK
 FULL_TYPE_SPEC
 DERIVABLE_SPEC
 TYPE_SPEC

NODE ATTRIBUTES:

(NODE SPECIFIC):
 sm_index_s : index_s
 sm_comp_type : TYPE_SPEC
 (INHERITED FROM UNCONSTRAINED_COMPOSITE):
 sm_is_limited : Boolean
 sm_is_packed : Boolean
 (INHERITED FROM UNCONSTRAINED):
 sm_size : EXP
 (INHERITED FROM NON_TASK):
 sm_base_type : TYPE_SPEC
 (INHERITED FROM DERIVABLE_SPEC):
 sm_derived : TYPE_SPEC
 sm_is_anonymous : Boolean

**** assign**

IS INCLUDED IN:

STM_WITH_EXP_NAME
 STM_WITH_EXP
 STM
 STM_ELEM
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM STM_WITH_EXP_NAME):
 as_name : NAME

```

      (INHERITED FROM STM_WITH_EXP):
          as_exp          : EXP
      (INHERITED FROM ALL_SOURCE):
          lx_srcpos       : source_position
          lx_comments     : comments
  
```

**** assoc**

```

      IS INCLUDED IN:
          NAMED_ASSOC
          GENERAL_ASSOC
          ALL_SOURCE
      NODE ATTRIBUTES:
          (NODE SPECIFIC):
              as_used_name : USED_NAME
          (INHERITED FROM NAMED_ASSOC):
              as_exp       : EXP
          (INHERITED FROM ALL_SOURCE):
              lx_srcpos    : source_position
              lx_comments  : comments
  
```

**** attribute**

```

      IS INCLUDED IN:
          NAME_VAL
          NAME_EXP
          NAME
          EXP
          GENERAL_ASSOC
          ALL_SOURCE
      NODE ATTRIBUTES:
          (NODE SPECIFIC):
              as_used_name_id : used_name_id
              as_exp         : EXP
          (INHERITED FROM NAME_VAL):
              sm_value       : value
          (INHERITED FROM NAME_EXP):
              as_name        : NAME
              sm_exp_type    : TYPE_SPEC
          (INHERITED FROM ALL_SOURCE):
              lx_srcpos      : source_position
              lx_comments    : comments
  
```

**** attribute_id**

```

      IS INCLUDED IN:
          PPEDEF_NAME
          DEF_NAME
          ALL_SOURCE
      NODE ATTRIBUTES:
          (INHERITED FROM DEF_NAME):
              lx_symrep      : symbol_rep
          (INHERITED FROM ALL_SOURCE):
              lx_srcpos      : source_position
  
```

```

                                lx_comments          : comments

** block

    IS INCLUDED IN:
        BLOCK_LOOP
        STM
        STM_ELEM
        ALL_SOURCE
    NODE ATTRIBUTES:
        (NODE SPECIFIC):
            as_block_body          : block_body
        (INHERITED FROM BLOCK_LOOP):
            as_source_name         : SOURCE_NAME
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos              : source_position
            lx_comments            : comments

** block_body

    IS INCLUDED IN:
        BODY
        UNIT_OESC
        ALL_SOURCE
    NODE ATTRIBUTES:
        (NODE SPECIFIC):
            as_item_s              : item_s
            as_alternative_s       : alternative_s
            as_stm_s               : stm_s
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos              : source_position
            lx_comments            : comments
    IS THE DECLARED TYPE OF:
        block.as_block_body

** BLOCK_LOOP

    CLASS MEMBERS:
        loop
        block
    IS INCLUDED IN:
        STM
        STM_ELEM
        ALL_SOURCE
    NODE ATTRIBUTES:
        (NODE SPECIFIC):
            as_source_name         : SOURCE_NAME
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos              : source_position
            lx_comments            : comments

** block_loop_id

    IS INCLUDED IN:

```



```

    LABEL_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM LABEL_NAME):
      sm_stm : STM
    (INHERITED FROM DEF_NAME):
      lx_symrep : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  
```

** block_master

```

    IS INCLUDED IN:
      ALL_DECL
      ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_stm : STM
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  
```

** bltn_operator_id

```

    IS INCLUDED IN:
      PREDEF_NAME
      DEF_NAME
      ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_operator : operator
    (INHERITED FROM DEF_NAME):
      lx_symrep : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  
```

** BODY

```

    CLASS MEMBERS:
      block_body
      void
      stub
    IS INCLUDED IN:
      UNIT_DESC
      ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  IS THE DECLARED TYPE OF:
  
```

generic_id.sm_body
 SUBUNIT_BODY.as_body
 task_body_id.sm_body
 task_spec.sm_body

**** box_default**

IS INCLUDED IN:
 GENERIC_PARAM
 UNIT_KIND
 UNIT_DESC
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** CALL_STM**

CLASS MEMBERS:
 entry_call
 procedure_call
 IS INCLUDED IN:
 STM_WITH_NAME
 STM
 STM_ELEM
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_general_assoc_s : general_assoc_s
 sm_normalized_param_s : exp_s
 (INHERITED FROM STM_WITH_NAME):
 as_name : NAME
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** case**

IS INCLUDED IN:
 STM_WITH_EXP
 STM
 STM_ELEM
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_alternative_s : alternative_s
 (INHERITED FROM STM_WITH_EXP):
 as_exp : EXP
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** character_id**

IS INCLUDED IN:
 ENUM_LITERAL
 OBJECT_NAME
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ENUM_LITERAL):
 sm_pos : Integer
 sm_rep : Integer
 (INHERITED FROM OBJECT_NAME):
 sm_obj_type : TYPE_SPEC
 (INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** CHOICE**

CLASS MEMBERS:
 choice_exp
 choice_others
 choice_range
IS INCLUDED IN:
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 choice_s.as_list [Seq Of]

**** choice_exp**

IS INCLUDED IN:
 CHOICE
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_exp : EXP
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** choice_others**

IS INCLUDED IN:
 CHOICE
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position

```

                                lx_comments          : comments

** choice_range
    IS INCLUDED IN:
        CHOICE
        ALL_SOURCE
    NODE ATTRIBUTES:
        (NODE SPECIFIC):
            as_discrete_range          : DISCRETE_RANGE
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos                  : source_position
            lx_comments                 : comments

** choice_s
    IS INCLUDED IN:
        SEQUENCES
        ALL_SOURCE
    NODE ATTRIBUTES:
        (NODE SPECIFIC):
            as_list                    : Seq OF CHOICE
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos                  : source_position
            lx_comments                 : comments
    IS THE DECLARED TYPE OF:
        alternative.as_choice_s
        named.as_choice_s
        variant.as_choice_s

** CLAUSES_STM
    CLASS MEMBERS:
        if
        selective_wait
    IS INCLUDED IN:
        STM
        STM_ELEM
        ALL_SOURCE
    NODE ATTRIBUTES:
        (NODE SPECIFIC):
            as_test_clause_elem_s      : test_clause_elem_s
            as_stm_s                   : stm_s
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos                  : source_position
            lx_comments                 : comments

** code
    IS INCLUDED IN:
        STM_WITH_EXP_NAME
        STM_WITH_EXP
        STM
        STM_ELEM
  
```

```

    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM STM_WITH_EXP_NAME):
      as_name : NAME
    (INHERITED FROM STM_WITH_EXP):
      as_exp : EXP
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

```

** comp_list

```

  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_decl_s : decl_s
      as_pragma_s : pragma_s
      as_variant_part : VARIANT_PART
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  IS THE DECLARED TYPE OF:
    variant.as_comp_list
    record.sm_comp_list
    record_def.as_comp_list

```

** COMP_NAME

```

  CLASS MEMBERS:
    component_id
    discriminant_id
  IS INCLUDED IN:
    INIT_OBJECT_NAME
    OBJECT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_comp_rep : COMP_REP_ELEM
    (INHERITED FROM INIT_OBJECT_NAME):
      sm_init_exp : EXP
    (INHERITED FROM OBJECT_NAME):
      sm_obj_type : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
      lx_symrep : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

```

** comp_rep

```

  IS INCLUDED IN:

```

```

      COMP REP ELEM
      ALL SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_name      : NAME
      as_range     : RANGE
      as_exp       : EXP
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos    : source_position
      lx_comments  : comments

```

**** COMP_REP_ELEM**

```

  CLASS MEMBERS:
    comp_rep
    void
    comp_rep_pragma
  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos    : source_position
      lx_comments  : comments
  IS THE DECLARED TYPE OF:
    comp_rep_s.as_list [Seq Of]
    COMP_NAME.sm_comp_rep

```

**** comp_rep_pragma**

```

  IS INCLUDED IN:
    COMP_REP_ELEM
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_pragma    : pragma
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos    : source_position
      lx_comments  : comments

```

**** comp_rep_s**

```

  IS INCLUDED IN:
    SEQUENCES
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_list      : Seq Of COMP_REP_ELEM
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos    : source_position
      lx_comments  : comments
  IS THE DECLARED TYPE OF:
    record_rep.as_comp_rep_s

```

**** compilation**

IS INCLUDED IN:
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_compltn_unit_s : compltn_unit_s
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** compilation_unit

IS INCLUDED IN:
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_context_elem_s : context_elem_s
 as_pragma_s : pragma_s
 as_all_decl : ALL_DECL
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 compltn_unit_s.as_list [Seq Of]

** compltn_unit_s

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of compilation_unit
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 compilation.as_compltn_unit_s

** component_id

IS INCLUDED IN:
 COMP_NAME
 INIT_OBJECT_NAME
 OBJECT_NAME
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM COMP_NAME):
 sm_comp_rep : COMP_REP_ELEM
 (INHERITED FROM INIT_OBJECT_NAME):
 sm_init_exp : EXP
 (INHERITED FROM OBJECT_NAME):

```

        sm_obj_type           : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
        lx_symrep             : symbol_rep
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments

```

** cond_clause

```

    IS INCLUDED IN:
        TEST_CLAUSE
        TEST_CLAUSE_ELEM
        ALL_SOURCE
    NODE ATTRIBUTES:
    (INHERITED FROM TEST_CLAUSE):
        as_exp                : EXP
        as_stm_s              : stm_s
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments

```

** cond_entry

```

    IS INCLUDED IN:
        ENTRY_STM
        STM
        STM_ELEM
        ALL_SOURCE
    NODE ATTRIBUTES:
    (INHERITED FROM ENTRY_STM):
        as_stm_s1             : stm_s
        as_stm_s2             : stm_s
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments

```

** constant_decl

```

    IS INCLUDED IN:
        OBJECT_DECL
        EXP_DECL
        ID_S_DECL
        DECL
        ITEM
        ALL_DECL
        ALL_SOURCE
    NODE ATTRIBUTES:
    (INHERITED FROM OBJECT_DECL):
        as_type_def           : TYPE_DEF
    (INHERITED FROM EXP_DECL):
        as_exp                : EXP
    (INHERITED FROM ID_S_DECL):
        as_source_name_s      : source_name_s
    (INHERITED FROM ALL_SOURCE):

```


lx_srcpos	: source_position
lx_comments	: comments

**** constant_id**

IS INCLUDED IN:

VC_NAME
 INIT_OBJECT_NAME
 OBJECT_NAME
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

sm_first	: DEF_NAME
----------	------------

(INHERITED FROM VC_NAME):

sm_renames_obj	: Boolean
sm_address	: EXP

(INHERITED FROM INIT_OBJECT_NAME):

sm_init_exp	: EXP
-------------	-------

(INHERITED FROM OBJECT_NAME):

sm_obj_type	: TYPE_SPEC
-------------	-------------

(INHERITED FROM DEF_NAME):

lx_symrep	: symbol_rep
-----------	--------------

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

**** CONSTRAINED**

CLASS MEMBERS:

constrained_array
 constrained_access
 constrained_record

IS INCLUDED IN:

NON_TASK
 FULL_TYPE_SPEC
 DERIVABLE_SPEC
 TYPE_SPEC

NODE ATTRIBUTES:

(NODE SPECIFIC):

sm_depends_on_dscrm	: Boolean
---------------------	-----------

(INHERITED FROM NON_TASK):

sm_base_type	: TYPE_SPEC
--------------	-------------

(INHERITED FROM DERIVABLE_SPEC):

sm_derived	: TYPE_SPEC
sm_is_anonymous	: Boolean

**** constrained_access**

IS INCLUDED IN:

CONSTRAINED
 NON_TASK
 FULL_TYPE_SPEC

```

    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_desig_type      : TYPE_SPEC
    (INHERITED FROM CONSTRAINED):
      sm_depends_on_dscrmt : Boolean
    (INHERITED FROM NON_TASK):
      sm_base_type       : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived         : TYPE_SPEC
      sm_is_anonymous    : Boolean

```

** constrained_array

```

  IS INCLUDED IN:
    CONSTRAINED
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_index_subtype_s : scalar_s
    (INHERITED FROM CONSTRAINED):
      sm_depends_on_dscrmt : Boolean
    (INHERITED FROM NON_TASK):
      sm_base_type       : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived         : TYPE_SPEC
      sm_is_anonymous    : Boolean

```

** constrained_array_def

```

  IS INCLUDED IN:
    ARR_ACC_DER_DEF
    TYPE_DEF
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_constraint      : CONSTRAINT
    (INHERITED FROM ARR_ACC_DER_DEF):
      as_subtype_indication : subtype_indication
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos          : source_position
      lx_comments        : comments

```

** CONSTRAINED_DEF

```

  CLASS MEMBERS:
    subtype_indication
    integer_def
    fixed_def
    float_def

```

```

IS INCLUDED IN:
    TYPE DEF
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_constraint          : CONSTRAINT
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments
  
```

**** constrained_record**

```

IS INCLUDED IN:
    CONSTRAINED
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        sm_normalized_dscrmt_s : exp_s
    (INHERITED FROM CONSTRAINED):
        sm_depends_on_dscrmt   : Boolean
    (INHERITED FROM NON_TASK):
        sm_base_type           : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
        sm_derived              : TYPE_SPEC
        sm_is_anonymous         : Boolean
  
```

**** CONSTRAINT**

```

CLASS MEMBERS:
    void
    DISCRETE_RANGE
    dscrmt_constraint
    index_constraint
    REAL CONSTRAINT
    RANGE
    discrete_subtype
    float_constraint
    fixed_constraint
    range
    range_attribute
IS INCLUDED IN:
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments
IS THE DECLARED TYPE OF:
    constrained_array_def.as_constraint
    CONSTRAINED_DEF.as_constraint
  
```

**** CONTEXT_ELEM**

CLASS MEMBERS:
 context_pragma
 with
IS INCLUDED IN:
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 context_elem_s.as_list [Seq Of]

** context_elem_s

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of CONTEXT_ELEM
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 compilation_unit.as_context_elem_s

** context_pragma

IS INCLUDED IN:
 CONTEXT_ELEM
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_pragma : pragma
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** conversion

IS INCLUDED IN:
 QUAL_CONV
 EXP_VAL_EXP
 EXP_VAL
 EXP_EXP
 EXP
 GENERAL ASSOC
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM QUAL_CONV):
 as_name : NAME
 (INHERITED FROM EXP_VAL_EXP):
 as_exp : EXP

(INHERITED FROM EXP_VAL):	
sm_value	: value
(INHERITED FROM EXP_EXP):	
sm_exp_type	: TYPE_SPEC
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

**** DECL**

CLASS MEMBERS:

ID_S_DECL
 ID_DECL
 null_comp_decl
 REP
 USE_PRAGMA
 EXP_DECL
 deferred_constant_decl
 exception_decl
 type_decl
 UNIT_DECL
 task_decl
 subtype_decl
 SIMPLE_RENAME_DECL
 void
 NAMED_REP
 record_rep
 use
 pragma
 OBJECT_DECL
 number_decl
 generic_decl
 NON_GENERIC_DECL
 renames_obj_decl
 renames_exc_decl
 length_enum_rep
 address
 constant_decl
 variable_decl
 subprog_entry_decl
 package_decl

IS INCLUDED IN:

ITEM
 ALL_DECL
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

IS THE DECLARED TYPE OF:

decl_s.as_list [Seq Of]

**** decl_s**

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of DECL
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 instantiation.sm_decl_s
 task_spec.sm_decl_s
 task_decl.as_decl_s
 package_spec.as_decl_s1
 .as_decl_s2
 comp_list.as_decl_s

** DEF_NAME

CLASS MEMBERS:
 SOURCE_NAME
 PREDEF_NAME
 OBJECT_NAME
 LABEL_NAME
 UNIT_NAME
 TYPE_NAME
 void
 entry_id
 exception_id
 attribute_id
 bltn_operator_id
 argument_id
 pragma_id
 INIT_OBJECT_NAME
 ENUM_LITERAL
 iteration_id
 label_id
 block_loop_id
 NON_TASK_NAME
 task_body_id
 type_id
 subtype_id
 private_type_id
 l_private_type_id
 VC_NAME
 number_id
 COMP_NAME
 PARAM_NAME
 enumeration_id
 character_id
 SUBPROG_PACK_NAME
 generic_id
 variable_id
 constant_id

```

    component_id
    discriminant_id
    in_id
    out_id
    in_out_id
    SUBPROG_NAME
    package_id
    procedure_id
    operator_id
    function_id
  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      lx_symrep          : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos          : source_position
      lx_comments        : comments
  IS THE DECLARED TYPE OF:
    PARAM_NAME.sm_first
    DESIGNATOR.sm_defn
    discriminant_id.sm_first
    type_id.sm_first
    constant_id.sm_first
    UNIT_NAME.sm_first

```

** deferred_constant_decl

```

  IS INCLUDED IN:
    ID_S_DECL
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_name            : NAME
    (INHERITED FROM ID_S_DECL):
      as_source_name_s   : source_name_s
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos          : source_position
      lx_comments        : comments

```

** delay

```

  IS INCLUDED IN:
    STM_WITH_EXP
    STM
    STM_ELEM
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM STM_WITH_EXP):
      as_exp             : EXP
    (INHERITED FROM ALL_SOURCE):

```

lx_srcpos	: source_position
lx_comments	: comments

**** DERIVABLE_SPEC**

CLASS MEMBERS:

FULL_TYPE_SPEC
PRIVATE_SPEC
task_spec
NON_TASK
private
!_private
SCALAR
CONSTRAINED
UNCONSTRAINED
enumeration
REAL
integer
constrained_array
constrained_access
constrained_record
UNCONSTRAINED_COMPOSITE
access
float
fixed
array
record

IS INCLUDED IN:

TYPE_SPEC

NODE ATTRIBUTES:

(NODE SPECIFIC):

sm_derived	: TYPE_SPEC
sm_is_anonymous	: Boolean

**** derived_def**

IS INCLUDED IN:

APP_ACC_DER_DEF
TYPE_DEF
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM APP_ACC_DER_DEF):

as_subtype_indication	: subtype_indication
-----------------------	----------------------

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

**** derived_subprog**

IS INCLUDED IN:

UNIT_DESC
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):


```

      sm_derivable      : SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos         : source_position
      lx_comments       : comments
  
```

**** DESIGNATOR**

```

    CLASS MEMBERS:
      USED_OBJECT
      USED_NAME
      used_char
      used_object_id
      used_op
      used_name_id
    IS INCLUDED IN:
      NAME
      EXP
      GENERAL ASSOC
      ALL_SOURCE
    NODE ATTRIBUTES:
      (NODE SPECIFIC):
        sm_defn          : DEF_NAME
        lx_symrep        : symbol_rep
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos        : source_position
        lx_comments      : comments
    IS THE DECLARED TYPE OF:
      selected.as_designator
  
```

**** DISCRETE_RANGE**

```

    CLASS MEMBERS:
      RANGE
      discrete_subtype
      range
      void
      range_attribute
    IS INCLUDED IN:
      CONSTRAINT
      ALL_SOURCE
    NODE ATTRIBUTES:
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos        : source_position
        lx_comments      : comments
    IS THE DECLARED TYPE OF:
      entry.as_discrete_range
      FOR_REV.as_discrete_range
      AGG_EXP.sm_discrete_range
      slice.as_discrete_range
      choice_range.as_discrete_range
      discrete_range_s.as_list [Seq Of]
  
```

**** discrete_range_s**

IS INCLUDED IN:
SEQUENCES
ALL_SOURCE
NODE ATTRIBUTES:
(NODE SPECIFIC):
 as_list : Seq Of DISCRETE_RANGE
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 index_constraint.as_discrete_range_s

** discrete_subtype

IS INCLUDED IN:
DISCRETE_RANGE
CONSTRAINT
ALL_SOURCE
NODE ATTRIBUTES:
(NODE SPECIFIC):
 as_subtype_indication : subtype_indication
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** discriminant_id

IS INCLUDED IN:
COMP_NAME
INIT_OBJECT_NAME
OBJECT_NAME
SOURCE_NAME
DEF_NAME
ALL_SOURCE
NODE ATTRIBUTES:
(NODE SPECIFIC):
 sm_first : DEF_NAME
(INHERITED FROM COMP_NAME):
 sm_comp_rep : COMP_REP_ELEM
(INHERITED FROM INIT_OBJECT_NAME):
 sm_init_exp : EXP
(INHERITED FROM OBJECT_NAME):
 sm_obj_type : TYPE_SPEC
(INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** dscrmt_constraint

IS INCLUDED IN:
CONSTRAINT
ALL_SOURCE

```

NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_general_assoc_s      : general_assoc_s
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos               : source_position
    lx_comments              : comments

```

**** dscrmt_decl**

```

IS INCLUDED IN:
  DSCRMT_PARAM_DECL
  ITEM
  ALL_DECL
  ALL_SOURCE
NODE ATTRIBUTES:
  (INHERITED FROM DSCRMT_PARAM_DECL):
    as_source_name_s        : source_name_s
    as_exp                   : EXP
    as_name                   : NAME
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos               : source_position
    lx_comments              : comments
IS THE DECLARED TYPE OF:
  dscrmt_decl_s.as_list [Seq Of]

```

**** dscrmt_decl_s**

```

IS INCLUDED IN:
  SEQUENCES
  ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_list                  : Seq Of dscrmt_decl
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos               : source_position
    lx_comments              : comments
IS THE DECLARED TYPE OF:
  PRIVATE_SPEC.sm_discriminant_s
  incomplete.sm_discriminant_s
  record.sm_discriminant_s
  type_decl.as_dscrmt_decl_s

```

**** DSCRMT_PARAM_DECL**

```

CLASS MEMBERS:
  dscrmt_decl
  PARAM
  in
  in_out
  out
IS INCLUDED IN:
  ITEM
  ALL_DECL
  ALL_SOURCE

```

NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_source_name_s : source_name_s
 as_exp : EXP
 as_name : NAME
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** entry

IS INCLUDED IN:
 SUBP_ENTRY_HEADER
 HEADER
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_discrete_range : DISCRETE_RANGE
 (INHERITED FROM SUBP_ENTRY_HEADER):
 as_param_s : param_s
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** entry_call

IS INCLUDED IN:
 CALL_STM
 STM_WITH_NAME
 STM
 STM_ELEM
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM CALL_STM):
 as_general_assoc_s : general_assoc_s
 sm_normalized_param_s : exp_s
 (INHERITED FROM STM_WITH_NAME):
 as_name : NAME
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** entry_id

IS INCLUDED IN:
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 sm_spec : HEADER
 sm_address : EXP
 (INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep

```

      (INHERITED FROM ALL_SOURCE):
          lx_srcpos      : source_position
          lx_comments    : comments

** ENTRY_STM

  CLASS MEMBERS:
      cond_entry
      timed_entry
  IS INCLUDED IN:
      STM
      STM_ELEM
      ALL_SOURCE
  NODE ATTRIBUTES:
      (NODE SPECIFIC):
          as_stm_s1      : stm_s
          as_stm_s2      : stm_s
      (INHERITED FROM ALL_SOURCE):
          lx_srcpos      : source_position
          lx_comments    : comments

** ENUM_LITERAL

  CLASS MEMBERS:
      enumeration_id
      character_id
  IS INCLUDED IN:
      OBJECT_NAME
      SOURCE_NAME
      DEF_NAME
      ALL_SOURCE
  NODE ATTRIBUTES:
      (NODE SPECIFIC):
          sm_pos          : Integer
          sm_rep          : Integer
      (INHERITED FROM OBJECT_NAME):
          sm_obj_type     : TYPE_SPEC
      (INHERITED FROM DEF_NAME):
          lx_symrep       : symbol_rep
      (INHERITED FROM ALL_SOURCE):
          lx_srcpos       : source_position
          lx_comments     : comments
  IS THE DECLARED TYPE OF:
      enum_literal_s.as_list [Seq Of]

** enum_literal_s

  IS INCLUDED IN:
      SEQUENCES
      ALL_SOURCE
  NODE ATTRIBUTES:
      (NODE SPECIFIC):
          as_list         : Seq Of ENUM_LITERAL
      (INHERITED FROM ALL_SOURCE):

```

```

    lx_srcpos      : source_position
    lx_comments    : comments
  IS THE DECLARED TYPE OF:
    enumeration.sm_literal_s
    enumeration_def.as_enum_literal_s

```

**** enumeration**

```

  IS INCLUDED IN:
    SCALAR
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_literal_s      : enum_literal_s
    (INHERITED FROM SCALAR):
      sm_range          : RANGE
      cd_impl_size      : Integer
    (INHERITED FROM NON_TASK):
      sm_base_type      : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived        : TYPE_SPEC
      sm_is_anonymous   : Boolean

```

**** enumeration_def**

```

  IS INCLUDED IN:
    TYPE_DEF
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_enum_literal_s : enum_literal_s
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos          : source_position
      lx_comments        : comments

```

**** enumeration_id**

```

  IS INCLUDED IN:
    ENUM_LITERAL
    OBJECT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ENUM_LITERAL):
      sm_pos             : Integer
      sm_rep             : Integer
    (INHERITED FROM OBJECT_NAME):
      sm_obj_type        : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
      lx_symrep          : symbol_rep

```

```

      (INHERITED FROM ALL_SOURCE):
          lx_srcpos      : source_position
          lx_comments    : comments

** exception_decl

      IS INCLUDED IN:
          ID_S_DECL
          DECL
          ITEM
          ALL_DECL
          ALL_SOURCE
      NODE ATTRIBUTES:
          (INHERITED FROM ID_S_DECL):
              as_source_name_s      : source_name_s
          (INHERITED FROM ALL_SOURCE):
              lx_srcpos      : source_position
              lx_comments    : comments

** exception_id

      IS INCLUDED IN:
          SOURCE_NAME
          DEF_NAME
          ALL_SOURCE
      NODE ATTRIBUTES:
          (NODE SPECIFIC):
              sm_renames_exc      : NAME
          (INHERITED FROM DEF_NAME):
              lx_symrep          : symbol_rep
          (INHERITED FROM ALL_SOURCE):
              lx_srcpos      : source_position
              lx_comments    : comments

** exit

      IS INCLUDED IN:
          STM_WITH_EXP_NAME
          STM_WITH_EXP
          STM
          STM_ELEM
          ALL_SOURCE
      NODE ATTRIBUTES:
          (NODE SPECIFIC):
              sm_stm              : STM
          (INHERITED FROM STM_WITH_EXP_NAME):
              as_name              : NAME
          (INHERITED FROM STM_WITH_EXP):
              as_exp              : EXP
          (INHERITED FROM ALL_SOURCE):
              lx_srcpos      : source_position
              lx_comments    : comments

** EXP
  
```

CLASS MEMBERS:

void
NAME
EXP EXP
DESIGNATOR
NAME EXP
EXP VAL
subType_allocator
qualified_allocator
AGG EXP
USED_OBJECT
USED_NAME
NAME_VAL
all
slice
indexed
short_circuit
numeric_literal
EXP VAL EXP
null_access
aggregate
string_literal
used_char
used_object_id
used_op
used_name_id
attribute
selected
function_call
MEMBERSHIP
QUAL_CONV
parenthesized
range_membership
type_membership
conversion
qualified

IS INCLUDED IN:

GENERAL ASSOC
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
lx_comments : comments

IS THE DECLARED TYPE OF:

comp_rep.as_exp
alignment.as_exp
NAMED_REP.as_exp
entry_id.sm_address
task_spec.sm_storage_size
 .sm_size
 .sm_address
SUBPROG_PACK_NAME.sm_address
while.as_exp


```

TEST_CLAUSE.as_exp
STM_WITH_EXP.as_exp
EXP_VAL_EXP.as_exp
short_circuit.as_expl
               .as_exp2
NAMED_ASSOC.as_exp
attribute.as_exp
exp_s.as_list [Seq Of]
access.sm_storage_size
choice_exp.as_exp
OSCRMT_PARAM_DECL.as_exp
REAL_CONSTRAINT.as_exp
range_attribute.as_exp
range.as_expl
               .as_exp2
UNCONSTRAINED.sm_size
VC_NAME.sm_address
INIT_OBJECT_NAME.sm_init_exp
EXP_DECL.as_exp
  
```

** EXP_DECL

```

CLASS MEMBERS:
  OBJECT_DECL
  number_decl
  constant_decl
  variable_decl
IS INCLUDED IN:
  ID_S_DECL
  DECL
  ITEM
  ALL_DECL
  ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_exp : EXP
  (INHERITED FROM ID_S_DECL):
    as_source_name_s : source_name_s
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos : source_position
    lx_comments : comments
  
```

** EXP_EXP

```

CLASS MEMBERS:
  EXP_VAL
  subtype_allocator
  qualified_allocator
  AGG_EXP
  short_circuit
  numeric_literal
  EXP_VAL_EXP
  null_access
  aggregate
  
```

```

    string_literal
    MEMBERSHIP
    QUAL_CONV
    parenthesized
    range_membership
    type_membership
    conversion
    qualified
IS INCLUDED IN:
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        sm_exp_type           : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments

```

** exp_s

```

IS INCLUDED IN:
    SEQUENCES
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_list               : Seq Of EXP
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments
IS THE DECLARED TYPE OF:
    function_call.sm_normalized_param_s
    CALL_STM.sm_normalized_param_s
    indexed.as_exp_s
    constrained_record.sm_normalized_dscrmt_s

```

** EXP_VAL

```

CLASS MEMBERS:
    short_circuit
    numeric_literal
    EXP_VAL_EXP
    null_access
    MEMBERSHIP
    QUAL_CONV
    parenthesized
    range_membership
    type_membership
    conversion
    qualified
IS INCLUDED IN:
    EXP_EXP
    EXP
    GENERAL_ASSOC

```

```

    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_value           : value
    (INHERITED FROM EXP_EXP):
      sm_exp_type        : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos          : source_position
      lx_comments        : comments
  
```

**** EXP_VAL_EXP**

```

    CLASS MEMBERS:
      MEMBERSHIP
      QUAL_CONV
      parenthesized
      range_membership
      type_membership
      conversion
      qualified
  IS INCLUDED IN:
    EXP_VAL
    EXP_EXP
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_exp             : EXP
    (INHERITED FROM EXP_VAL):
      sm_value           : value
    (INHERITED FROM EXP_EXP):
      sm_exp_type        : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos          : source_position
      lx_comments        : comments
  
```

**** fixed**

```

  IS INCLUDED IN:
    REAL
    SCALAR
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      cd_impl_small      : value
    (INHERITED FROM REAL):
      sm_accuracy         : value
    (INHERITED FROM SCALAR):
      sm_range            : RANGE
      cd_impl_size        : Integer
  
```

```
(INHERITED FROM NON_TASK):
    sm_base_type      : TYPE_SPEC
(INHERITED FROM DERIVABLE_SPEC):
    sm_derived        : TYPE_SPEC
    sm_is_anonymous   : Boolean
```

**** fixed_constraint**

```
IS INCLUDED IN:
    REAL CONSTRAINT
    CONSTRAINT
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM REAL_CONSTRAINT):
        sm_type_spec      : TYPE_SPEC
        as_exp            : EXP
        as_range          : RANGE
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos         : source_position
        lx_comments       : comments
```

**** fixed_def**

```
IS INCLUDED IN:
    CONSTRAINED_DEF
    TYPE_DEF
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM CONSTRAINED_DEF):
        as_constraint      : CONSTRAINT
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos         : source_position
        lx_comments       : comments
```

**** float**

```
IS INCLUDED IN:
    REAL
    SCALAR
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
NODE ATTRIBUTES:
    (INHERITED FROM REAL):
        sm_accuracy       : value
    (INHERITED FROM SCALAR):
        sm_range          : RANGE
        cd_impl_size      : Integer
    (INHERITED FROM NON_TASK):
        sm_base_type      : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
        sm_derived        : TYPE_SPEC
        sm_is_anonymous   : Boolean
```

** float_constraint

IS INCLUDED IN:

REAL CONSTRAINT
CONSTRAINT
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM REAL_CONSTRAINT):

sm_type_spec : TYPE_SPEC
as_exp : EXP
as_range : RANGE

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
lx_comments : comments

** float_def

IS INCLUDED IN:

CONSTRAINED_DEF
TYPE_DEF
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM CONSTRAINED_DEF):

as_constraint : CONSTRAINT

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
lx_comments : comments

** for

IS INCLUDED IN:

FOR_REV
ITERATION
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM FOR_REV):

as_source_name : SOURCE_NAME
as_discrete_range : DISCRETE_RANGE

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
lx_comments : comments

** FOR_REV

CLASS MEMBERS:

for
reverse

IS INCLUDED IN:

ITERATION
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_source_name : SOURCE_NAME

```
        as_discrete_range      : DISCRETE_RANGE  
(INHERITED FROM ALL_SOURCE):  
        lx_srcpos              : source_position  
        lx_comments            : comments
```

**** formal_dscrt_def**

```
IS INCLUDED IN:  
    TYPE_DEF  
    ALL_SOURCE  
NODE ATTRIBUTES:  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos      : source_position  
    lx_comments    : comments
```

**** formal_fixed_def**

```
IS INCLUDED IN:  
    TYPE_DEF  
    ALL_SOURCE  
NODE ATTRIBUTES:  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos      : source_position  
    lx_comments    : comments
```

**** formal_float_def**

```
IS INCLUDED IN:  
    TYPE_DEF  
    ALL_SOURCE  
NODE ATTRIBUTES:  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos      : source_position  
    lx_comments    : comments
```

**** formal_integer_def**

```
IS INCLUDED IN:  
    TYPE_DEF  
    ALL_SOURCE  
NODE ATTRIBUTES:  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos      : source_position  
    lx_comments    : comments
```

**** FULL_TYPE_SPEC**

```
CLASS MEMBERS:  
    task_spec  
    NON_TASK  
    SCALAR  
    CONSTRAINED  
    UNCONSTRAINED  
    enumeration
```

```

    REAL
    integer
    constrained_array
    constrained_access
    constrained_record
    UNCONSTRAINED_COMPOSITE
    access
    float
    fixed
    array
    record
  IS INCLUDED IN:
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived      : TYPE_SPEC
      sm_is_anonymous : Boolean

```

** function_call

```

  IS INCLUDED IN:
    NAME_VAL
    NAME_EXP
    NAME
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_general_assoc_s : general_assoc_s
      sm_normalized_param_s : exp_s
      lx_prefix          : Boolean
    (INHERITED FROM NAME_VAL):
      sm_value : value
    (INHERITED FROM NAME_EXP):
      as_name : NAME
      sm_exp_type : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

```

** function_id

```

  IS INCLUDED IN:
    SUBPROG_NAME
    SUBPROG_PACK_NAME
    NON_TASK_NAME
    UNIT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM SUBPROG_NAME):

```

```

      sm_is_inline      : Boolean
      sm_interface      : PREDEF_NAME
      (INHERITED FROM SUBPROG_PACK_NAME):
      sm_unit_desc      : UNIT_DESC
      sm_address        : EXP
      (INHERITED FROM NON_TASK_NAME):
      sm_spec           : HEADER
      (INHERITED FROM UNIT_NAME):
      sm_first          : DEF_NAME
      (INHERITED FROM DEF_NAME):
      lx_symrep         : symbol_rep
      (INHERITED FROM ALL_SOURCE):
      lx_srcpos         : source_position
      lx_comments       : comments
  
```

** function_spec

```

      IS INCLUDED IN:
      SUBP_ENTRY_HEADER
      HEADER
      ALL_SOURCE
      NODE ATTRIBUTES:
      (NODE SPECIFIC):
      as_name           : NAME
      (INHERITED FROM SUBP_ENTRY_HEADER):
      as_param_s        : param_s
      (INHERITED FROM ALL_SOURCE):
      lx_srcpos         : source_position
      lx_comments       : comments
  
```

** GENERAL_ASSOC

```

      CLASS MEMBERS:
      NAMED_ASSOC
      EXP
      named
      assoc
      void
      NAME
      EXP_EXP
      DESIGNATOR
      NAME_EXP
      EXP_VAL
      subtype_allocator
      qualified_allocator
      AGG_EXP
      USED_OBJECT
      USED_NAME
      NAME_VAL
      all
      slice
      indexed
      short_circuit
      numeric_literal
  
```



```

    EXP_VAL_EXP
    null_access
    aggregate
    string_literal
    used_char
    used_object_id
    used_op
    used_name_id
    attribute
    selected
    function_call
    MEMBERSHIP
    QUAL_CONV
    parenthesized
    range_membership
    type_membership
    conversion
    qualified
  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos      : source_position
        lx_comments    : comments
  IS THE DECLARED TYPE OF:
    general_assoc_s.as_list [Seq Of]

```

**** general_assoc_s**

```

  IS INCLUDED IN:
    SEQUENCES
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_list      : Seq Of GENERAL_ASSOC
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos    : source_position
        lx_comments  : comments
  IS THE DECLARED TYPE OF:
    instantiation.as_general_assoc_s
    function_call.as_general_assoc_s
    CALL_STM.as_general_assoc_s
    aggregate.as_general_assoc_s
    .sm_normalized_comp_s
    dscrmnt_constraint.as_general_assoc_s
    pragma.as_general_assoc_s

```

**** generic_decl**

```

  IS INCLUDED IN:
    UNIT_DECL
    ID_DECL
    DECL
    ITEM

```

```

    ALL_DECL
    ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_item_s          : item_s
  (INHERITED FROM UNIT_DECL):
    as_header          : HEADER
  (INHERITED FROM ID_DECL):
    as_source_name     : SOURCE_NAME
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos          : source_position
    lx_comments        : comments

```

**** generic_id**

```

IS INCLUDED IN:
  NON_TASK_NAME
  UNIT_NAME
  SOURCE_NAME
  DEF_NAME
  ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    sm_generic_param_s : item_s
    sm_is_inline        : Boolean
    sm_body             : BODY
  (INHERITED FROM NON_TASK_NAME):
    sm_spec             : HEADER
  (INHERITED FROM UNIT_NAME):
    sm_first            : DEF_NAME
  (INHERITED FROM DEF_NAME):
    lx_symrep           : symbol_rep
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos           : source_position
    lx_comments         : comments

```

**** GENERIC_PARAM**

```

CLASS MEMBERS:
  name_default
  no_default
  box_default
IS INCLUDED IN:
  UNIT_KIND
  UNIT_DESC
  ALL_SOURCE
NODE ATTRIBUTES:
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos          : source_position
    lx_comments        : comments

```

**** goto**

```

IS INCLUDED IN:

```

```

    STM_WITH_NAME
    STM
    STM_ELEM
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM STM_WITH_NAME):
      as_name : NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  
```

** HEADER

```

  CLASS MEMBERS:
    SUBP_ENTRY_HEADER
    package_spec
    procedure_spec
    function_spec
    entry
  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  IS THE DECLARED TYPE OF:
    entry_id.sm_spec
    subprogram_body.as_header
    NON_TASK_NAME.sm_spec
    UNIT_DECL.as_header
  
```

** ID_DECL

```

  CLASS MEMBERS:
    type_decl
    UNIT_DECL
    task_decl
    subtype_decl
    SIMPLE_RENAME_DECL
    generic_decl
    NON_GENERIC_DECL
    renames_obj_decl
    renames_exc_decl
    subprog_entry_decl
    package_decl
  IS INCLUDED IN:
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_source_name : SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
  
```

lx_srcpos	: source_position
lx_comments	: comments

**** ID_S_DECL**

CLASS MEMBERS:

EXP_DECL
 deferred_constant_decl
 exception_decl
 OBJECT_DECL
 number_decl
 constant_decl
 variable_decl

IS INCLUDED IN:

DECL
 ITEM
 ALL_DECL
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_source_name_s	: source_name_s
------------------	-----------------

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

**** if**

IS INCLUDED IN:

CLAUSES_STM
 STM
 STM_ELEM
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM CLAUSES_STM):

as_test_clause_elem_s	: test_clause_elem_s
as_stm_s	: stm_s

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

**** implicit_not_eq**

IS INCLUDED IN:

UNIT_DESC
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

sm_equal	: SOURCE_NAME
----------	---------------

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

**** in**

IS INCLUDED IN:

PARAM
DSCRMT_PARAM_DECL
ITEM
ALL_DECL
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

lx_default : Boolean

(INHERITED FROM DSCRMT_PARAM_DECL):

as_source_name_s : source_name_s

as_exp : EXP

as_name : NAME

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

** in_id

IS INCLUDED IN:

PARAM_NAME
INIT_OBJECT_NAME
OBJECT_NAME
SOURCE_NAME
DEF_NAME
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM PARAM_NAME):

sm_first : DEF_NAME

(INHERITED FROM INIT_OBJECT_NAME):

sm_init_exp : EXP

(INHERITED FROM OBJECT_NAME):

sm_obj_type : TYPE_SPEC

(INHERITED FROM DEF_NAME):

lx_symrep : symbol_rep

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

** in_op

IS INCLUDED IN:

MEMBERSHIP_OP
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

** in_out

IS INCLUDED IN:

PARAM
DSCRMT_PARAM_DECL

```

      ITEM
      ALL_DECL
      ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM DSCRMT_PARAM_DECL):
      as_source_name_s      : source_name_s
      as_exp                 : EXP
      as_name                : NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments

**  in_out_id

  IS INCLUDED IN:
    PARAM_NAME
    INIT_OBJECT_NAME
    OBJECT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM PARAM_NAME):
      sm_first              : DEF_NAME
    (INHERITED FROM INIT_OBJECT_NAME):
      sm_init_exp           : EXP
    (INHERITED FROM OBJECT_NAME):
      sm_obj_type           : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
      lx_symrep             : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments

**  incomplete

  IS INCLUDED IN:
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_discriminant_s     : dscrmt_decl_s

**  index

  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_name                : NAME
      sm_type_spec           : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments
  IS THE DECLARED TYPE OF:

```

index_s.as_list [Seq Of]

** index_constraint

IS INCLUDED IN:
 CONSTRAINT
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_discrete_range_s : discrete_range_s
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** index_s

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of index
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 array.sm_index_s
 unconstrained_array_def.as_index_s

** indexed

IS INCLUDED IN:
 NAME_EXP
 NAME
 EXP
 GENERAL ASSOC
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_exp_s : exp_s
 (INHERITED FROM NAME_EXP):
 as_name : NAME
 sm_exp_type : TYPE_SPEC
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** INIT_OBJECT_NAME

CLASS MEMBERS:
 VC_NAME
 number_id
 COMP_NAME
 PARAM_NAME

```

    variable_id
    constant_id
    component_id
    discriminant_id
    in_id
    out_id
    in_out_id
  IS INCLUDED IN:
    OBJECT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_init_exp          : EXP
    (INHERITED FROM OBJECT_NAME):
      sm_obj_type          : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
      lx_symrep            : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos            : source_position
      lx_comments          : comments

```

** instantiation

```

  IS INCLUDED IN:
    RENAME_INSTANT
    UNIT_KIND
    UNIT_DESC
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_general_assoc_s   : general_assoc_s
      sm_decl_s            : decl_s
    (INHERITED FROM RENAME_INSTANT):
      as_name              : NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos            : source_position
      lx_comments          : comments

```

** integer

```

  IS INCLUDED IN:
    SCALAR
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (INHERITED FROM SCALAR):
      sm_range             : RANGE
      cd_impl_size         : Integer
    (INHERITED FROM NON_TASK):
      sm_base_type         : TYPE_SPEC

```



```
(INHERITED FROM DERIVABLE_SPEC):  
    sm_derived      : TYPE_SPEC  
    sm_is_anonymous : Boolean
```

**** integer_def**

```
IS INCLUDED IN:  
    CONSTRAINED_DEF  
    TYPE_DEF  
    ALL_SOURCE  
NODE ATTRIBUTES:  
    (INHERITED FROM CONSTRAINED_DEF):  
        as_constraint : CONSTRAINT  
    (INHERITED FROM ALL_SOURCE):  
        lx_srcpos      : source_position  
        lx_comments    : comments
```

**** ITEM**

```
CLASS MEMBERS:  
    DSCRMT_PARAM_DECL  
    DECL  
    SUBUNIT_BODY  
    dscrmt_decl  
    PARAM  
    ID_S_DECL  
    ID_DECL  
    null_comp_decl  
    REP  
    USE_PRAGMA  
    subprogram_body  
    task_body  
    package_body  
    in  
    in_out  
    out  
    EXP_DECL  
    deferred_constant_decl  
    exception_decl  
    type_decl  
    UNIT_DECL  
    task_decl  
    subtype_decl  
    SIMPLE_RENAME_DECL  
    void  
    NAMED_REP  
    record_rep  
    use  
    pragma  
    OBJECT_DECL  
    number_decl  
    generic_decl  
    NON_GENERIC_DECL  
    renames_obj_decl
```

```

        renames_exc_decl
        length_enum_rep
        address
        constant_decl
        variable_decl
        subprog_entry_decl
        package_decl
    IS INCLUDED IN:
        ALL_DECL
        ALL_SOURCE
    NODE ATTRIBUTES:
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos      : source_position
            lx_comments    : comments
    IS THE DECLARED TYPE OF:
        item_s.as_list [Seq Of]

```

**** item_s**

```

    IS INCLUDED IN:
        SEQUENCES
        ALL_SOURCE
    NODE ATTRIBUTES:
        (NODE SPECIFIC):
            as_list      : Seq Of ITEM
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos    : source_position
            lx_comments  : comments
    IS THE DECLARED TYPE OF:
        generic_id.sm_generic_param_s
        generic_decl.as_item_s
        block_body.as_item_s

```

**** ITERATION**

```

    CLASS MEMBERS:
        void
        FOR REV
        while
        for
        reverse
    IS INCLUDED IN:
        ALL_SOURCE
    NODE ATTRIBUTES:
        (INHERITED FROM ALL_SOURCE):
            lx_srcpos    : source_position
            lx_comments  : comments
    IS THE DECLARED TYPE OF:
        loop.as_iteration

```

**** iteration_id**

```

    IS INCLUDED IN:
        OBJECT_NAME

```

```

    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM OBJECT_NAME):
      sm_obj_type      : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
      lx_symrep        : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos        : source_position
      lx_comments      : comments

** 1_private

  IS INCLUDED IN:
    PRIVATE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (INHERITED FROM PRIVATE_SPEC):
      sm_discriminant_s : dsclmt_decl_s
      sm_type_spec       : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived         : TYPE_SPEC
      sm_is_anonymous    : Boolean

** 1_private_def

  IS INCLUDED IN:
    TYPE_DEF
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos        : source_position
      lx_comments      : comments

** 1_private_type_id

  IS INCLUDED IN:
    TYPE_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM TYPE_NAME):
      sm_type_spec      : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
      lx_symrep         : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos         : source_position
      lx_comments       : comments

** label_id

```

IS INCLUDED IN:
 LABEL_NAME
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM LABEL_NAME):
 sm_stm : STM
 (INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** LABEL_NAME

CLASS MEMBERS:
 label_id
 block_loop_id
IS INCLUDED IN:
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 sm_stm : STM
 (INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** labeled

IS INCLUDED IN:
 STM
 STM_ELEM
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_source_name_s : source_name_s
 as_stm : STM
 as_pragma_s : pragma_s
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** length_enum_rep

IS INCLUDED IN:
 NAMED_REP
 REP
 DECL
 ITEM

```

ALL_DECL
ALL_SOURCE
NODE ATTRIBUTES:
  (INHERITED FROM NAMED_REP):
    as_exp : EXP
  (INHERITED FROM REP):
    as_name : NAME
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos : source_position
    lx_comments : comments

```

** loop

```

IS INCLUDED IN:
  BLOCK_LOOP
  STM
  STM_ELEM
  ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_iteration : ITERATION
    as_stm_s : stm_s
  (INHERITED FROM BLOCK_LOOP):
    as_source_name : SOURCE_NAME
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos : source_position
    lx_comments : comments

```

** MEMBERSHIP

```

CLASS MEMBERS:
  range_membership
  type_membership
IS INCLUDED IN:
  EXP_VAL_EXP
  EXP_VAL
  EXP_EXP
  EXP
  GENERAL_ASSOC
  ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_membership_op : MEMBERSHIP_OP
  (INHERITED FROM EXP_VAL_EXP):
    as_exp : EXP
  (INHERITED FROM EXP_VAL):
    sm_value : value
  (INHERITED FROM EXP_EXP):
    sm_exp_type : TYPE_SPEC
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos : source_position
    lx_comments : comments

```

** MEMBERSHIP_OP

CLASS MEMBERS:
 in_op
 not_in
IS INCLUDED IN:
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 MEMBERSHIP.as_membership_op

** NAME

CLASS MEMBERS:
 DESIGNATOR
 NAME_EXP
 void
 USED_OBJECT
 USED_NAME
 NAME_VAL
 all
 slice
 indexed
 used_char
 used_object_id
 used_op
 used_name_id
 attribute
 selected
 function_call
IS INCLUDED IN:
 EXP
 GENERAL_ASSOC
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 comp_rep.as_name
 REP.as_name
 name_default.as_name
 exception_id.sm_renames_exc
 subunit.as_name
 name_s.as_list [Seq Of]
 accept.as_name
 RENAME_INSTANT.as_name
 renames_obj_decl.as_type_mark_name
 SIMPLE_RENAME_DECL.as_name
 deferred_constant_decl.as_name
 function_spec.as_name
 STM_WITH_NAME.as_name

STM WITH EXP_NAME.as_name
QUAL_CONV.as_name
type_membership.as_name
NAME_EXP.as_name
variant_part.as_name
DSCRMT_PARAM_DECL.as_name
index.as_name
range_attribute.as_name
subtype_indication.as_name

**** name_default**

IS INCLUDED IN:

GENERIC_PARAM
UNIT_KIND
UNIT_DESC
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_name	: NAME
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

**** NAME_EXP**

CLASS MEMBERS:

NAME_VAL
all
slice
indexed
attribute
selected
function_call

IS INCLUDED IN:

NAME
EXP
GENERAL_ASSOC
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_name	: NAME
sm_exp_type	: TYPE_SPEC
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

**** name_s**

IS INCLUDED IN:

SEQUENCES
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

```

        as_list                : Seq Of NAME
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos              : source_position
        lx_comments            : comments
IS THE DECLARED TYPE OF:
    with.as_name_s
    abort.as_name_s
    use.as_name_s

```

** NAME_VAL

```

CLASS MEMBERS:
    attribute
    selected
    function_call
IS INCLUDED IN:
    NAME_EXP
    NAME_
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        sm_value                : value
    (INHERITED FROM NAME_EXP):
        as_name                 : NAME
        sm_exp_type             : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos               : source_position
        lx_comments             : comments

```

** named

```

IS INCLUDED IN:
    NAMED_ASSOC
    GENERAL_ASSOC
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_choice_s             : choice_s
    (INHERITED FROM NAMED_ASSOC):
        as_exp                  : EXP
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos               : source_position
        lx_comments             : comments

```

** NAMED_ASSOC

```

CLASS MEMBERS:
    named
    assoc
IS INCLUDED IN:
    GENERAL_ASSOC
    ALL_SOURCE

```


NODE ATTRIBUTES:
(NODE SPECIFIC):
 as_exp : EXP
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** NAMED_REP

CLASS MEMBERS:
 length_enum_rep
 address
IS INCLUDED IN:
 REP
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE
NODE ATTRIBUTES:
(NODE SPECIFIC):
 as_exp : EXP
(INHERITED FROM REP):
 as_name : NAME
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** no_default

IS INCLUDED IN:
 GENERIC_PARAM
 UNIT_KIND
 UNIT_DESC
 ALL_SOURCE
NODE ATTRIBUTES:
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** NON_GENERIC_DECL

CLASS MEMBERS:
 subprog_entry_decl
 package_decl
IS INCLUDED IN:
 UNIT_DECL
 ID_DECL
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE
NODE ATTRIBUTES:
(NODE SPECIFIC):
 as_unit_kind : UNIT_KIND

```
(INHERITED FROM UNIT_DECL):  
    as_header : HEADER  
(INHERITED FROM ID_DECL):  
    as_source_name : SOURCE_NAME  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos : source_position  
    lx_comments : comments
```

**** NON_TASK**

```
CLASS MEMBERS:  
    SCALAR  
    CONSTRAINED  
    UNCONSTRAINED  
    enumeration  
    REAL  
    integer  
    constrained_array  
    constrained_access  
    constrained_record  
    UNCONSTRAINED_COMPOSITE  
    access  
    float  
    fixed  
    array  
    record  
IS INCLUDED IN:  
    FULL_TYPE_SPEC  
    DERIVABLE_SPEC  
    TYPE_SPEC  
NODE ATTRIBUTES:  
(NODE SPECIFIC):  
    sm_base_type : TYPE_SPEC  
(INHERITED FROM DERIVABLE_SPEC):  
    sm_derived : TYPE_SPEC  
    sm_is_anonymous : Boolean
```

**** NON_TASK_NAME**

```
CLASS MEMBERS:  
    SUBPROG_PACK_NAME  
    generic_id  
    SUBPROG_NAME  
    package_id  
    procedure_id  
    operator_id  
    function_id  
IS INCLUDED IN:  
    UNIT_NAME  
    SOURCE_NAME  
    DEF_NAME  
    ALL_SOURCE  
NODE ATTRIBUTES:  
(NODE SPECIFIC):
```

```

      sm_spec                : HEADER
    (INHERITED FROM UNIT_NAME):
      sm_first               : DEF_NAME
    (INHERITED FROM DEF_NAME):
      lx_symrep              : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments

** not_in

  IS INCLUDED IN:
    MEMBERSHIP_OP
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments

** null_access

  IS INCLUDED IN:
    EXP_VAL
    EXP_EXP
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM EXP_VAL):
      sm_value                : value
    (INHERITED FROM EXP_EXP):
      sm_exp_type             : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments

** null_comp_decl

  IS INCLUDED IN:
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos              : source_position
      lx_comments            : comments

** null_stm

  IS INCLUDED IN:
    STM
    STM_ELEM
    ALL_SOURCE

```

NODE ATTRIBUTES:
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** number_decl

IS INCLUDED IN:
 EXP_DECL
 ID_S_DECL
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE
NODE ATTRIBUTES:
(INHERITED FROM EXP_DECL):
 as_exp : EXP
(INHERITED FROM ID_S_DECL):
 as_source_name_s : source_name_s
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** number_id

IS INCLUDED IN:
 INIT_OBJECT_NAME
 OBJECT_NAME
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE
NODE ATTRIBUTES:
(INHERITED FROM INIT_OBJECT_NAME):
 sm_init_exp : EXP
(INHERITED FROM OBJECT_NAME):
 sm_obj_type : TYPE_SPEC
(INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** numeric_literal

IS INCLUDED IN:
 EXP_VAL
 EXP_EXP
 EXP
 GENERAL_ASSOC
 ALL_SOURCE
NODE ATTRIBUTES:
(NODE SPECIFIC):
 lx_numrep : number_rep
(INHERITED FROM EXP_VAL):

sm_value	: value
(INHERITED FROM EXP_EXP):	
sm_exp_type	: TYPE_SPEC
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

** OBJECT_DECL

CLASS MEMBERS:

constant_decl
 variable_decl

IS INCLUDED IN:

EXP_DECL
 ID_S_DECL
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_type_def	: TYPE_DEF
(INHERITED FROM EXP_DECL):	
as_exp	: EXP
(INHERITED FROM ID_S_DECL):	
as_source_name_s	: source_name_s
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

** OBJECT_NAME

CLASS MEMBERS:

INIT_OBJECT_NAME
 ENUM_LITERAL
 iteration_id
 VC_NAME
 number_id
 COMP_NAME
 PARAM_NAME
 enumeration_id
 character_id
 variable_id
 constant_id
 component_id
 discriminant_id
 in_id
 out_id
 in_out_id

IS INCLUDED IN:

SOURCE_NAME
 DEF_NAME
 ALL_SOURCE

NODE ATTRIBUTES:

```
(NODE SPECIFIC):
    sm_obj_type      : TYPE_SPEC
(INHERITED FROM DEF_NAME):
    lx_symrep        : symbol_rep
(INHERITED FROM ALL_SOURCE):
    lx_srcpos        : source_position
    lx_comments      : comments
```

**** operator_id**

```
IS INCLUDED IN:
    SUBPROG_NAME
    SUBPROG_PACK NAME
    NON_TASK NAME
    UNIT NAME
    SOURCE NAME
    DEF_NAME
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM SUBPROG_NAME):
        sm_is_inline      : Boolean
        sm_interface      : PREDEF_NAME
    (INHERITED FROM SUBPROG_PACK_NAME):
        sm_unit_desc      : UNIT_DESC
        sm_address        : EXP
    (INHERITED FROM NON_TASK_NAME):
        sm_spec           : HEADER
    (INHERITED FROM UNIT_NAME):
        sm_first          : DEF_NAME
    (INHERITED FROM DEF_NAME):
        lx_symrep         : symbol_rep
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos         : source_position
        lx_comments       : comments
```

**** or_else**

```
IS INCLUDED IN:
    SHORT_CIRCUIT_OP
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos        : source_position
        lx_comments      : comments
```

**** out**

```
IS INCLUDED IN:
    PARAM
    DSCRMT_PARAM_DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
NODE ATTRIBUTES:
```

```
(INHERITED FROM DSCRMT_PARAM_DECL):  
    as_source_name_s      : source_name_s  
    as_exp                 : EXP  
    as_name                : NAME  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos              : source_position  
    lx_comments            : comments
```

**** out_id**

```
IS INCLUDED IN:  
    PARAM_NAME  
    INIT_OBJECT_NAME  
    OBJECT_NAME  
    SOURCE_NAME  
    DEF_NAME  
    ALL_SOURCE  
NODE ATTRIBUTES:  
(INHERITED FROM PARAM_NAME):  
    sm_first               : DEF_NAME  
(INHERITED FROM INIT_OBJECT_NAME):  
    sm_init_exp            : EXP  
(INHERITED FROM OBJECT_NAME):  
    sm_obj_type            : TYPE_SPEC  
(INHERITED FROM DEF_NAME):  
    lx_symrep              : symbol_rep  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos              : source_position  
    lx_comments            : comments
```

**** package_body**

```
IS INCLUDED IN:  
    SUBUNIT_BODY  
    ITEM  
    ALL_DECL  
    ALL_SOURCE  
NODE ATTRIBUTES:  
(INHERITED FROM SUBUNIT_BODY):  
    as_source_name         : SOURCE_NAME  
    as_body                : BODY  
(INHERITED FROM ALL_SOURCE):  
    lx_srcpos              : source_position  
    lx_comments            : comments
```

**** package_decl**

```
IS INCLUDED IN:  
    NON_GENERIC_DECL  
    UNIT_DECL  
    ID_DECL  
    DECL  
    ITEM  
    ALL_DECL
```

```

      ALL_SOURCE
NODE ATTRIBUTES:
  (INHERITED FROM NON_GENERIC_DECL):
    as_unit_kind      : UNIT_KIND
  (INHERITED FROM UNIT_DECL):
    as_header         : HEADER
  (INHERITED FROM ID_DECL):
    as_source_name    : SOURCE_NAME
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos         : source_position
    lx_comments       : comments
  
```

** package_id

```

  IS INCLUDED IN:
    SUBPROG PACK NAME
    NON_TASK NAME
    UNIT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
NODE ATTRIBUTES:
  (INHERITED FROM SUBPROG_PACK_NAME):
    sm_unit_desc      : UNIT_DESC
    sm_address        : EXP
  (INHERITED FROM NON_TASK_NAME):
    sm_spec           : HEADER
  (INHERITED FROM UNIT_NAME):
    sm_first          : DEF_NAME
  (INHERITED FROM DEF_NAME):
    lx_symrep         : symbol_rep
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos         : source_position
    lx_comments       : comments
  
```

** package_spec

```

  IS INCLUDED IN:
    HEADER
    ALL_SOURCE
NODE ATTRIBUTES:
  (NODE SPECIFIC):
    as_decl_s1        : decl_s
    as_decl_s2        : decl_s
  (INHERITED FROM ALL_SOURCE):
    lx_srcpos         : source_position
    lx_comments       : comments
  
```

** PARAM

```

  CLASS MEMBERS:
    in
    in_out
    out
  
```


IS INCLUDED IN:
 DSCRMT_PARAM_DECL
 ITEM
 ALL_DECL
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM DSCRMT_PARAM_DECL):
 as_source_name_s : source_name_s
 as_exp : EXP
 as_name : NAME
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 param_s.as_list [Seq Of]

** PARAM_NAME

CLASS MEMBERS:
 in_id
 out_id
 in_out_id
 IS INCLUDED IN:
 INIT_OBJECT_NAME
 OBJECT_NAME
 SOURCE_NAME
 DEF_NAME
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 sm_first : DEF_NAME
 (INHERITED FROM INIT_OBJECT_NAME):
 sm_init_exp : EXP
 (INHERITED FROM OBJECT_NAME):
 sm_obj_type : TYPE_SPEC
 (INHERITED FROM DEF_NAME):
 lx_symrep : symbol_rep
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** param_s

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of PARAM
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 accept.as_param_s

SUBP_ENTRY_HEADER.as_param_s

** parenthesized

```

IS INCLUDED IN:
    EXP_VAL_EXP
    EXP_VAL
    EXP_EXP
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM EXP_VAL_EXP):
        as_exp : EXP
    (INHERITED FROM EXP_VAL):
        sm_value : value
    (INHERITED FROM EXP_EXP):
        sm_exp_type : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos : source_position
        lx_comments : comments
  
```

** pragma

```

IS INCLUDED IN:
    USE_PRAGMA
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_used_name_id : used_name_id
        as_general_assoc_s : general_assoc_s
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos : source_position
        lx_comments : comments
IS THE DECLARED TYPE OF:
    comp_rep_pragma.as_pragma
    context_pragma.as_pragma
    pragma_s.as_list [Seq Of]
    select_alt_pragma.as_pragma
    alternative_pragma.as_pragma
    stm_pragma.as_pragma
    variant_pragma.as_pragma
  
```

** pragma_id

```

IS INCLUDED IN:
    PREDEF_NAME
    DEF_NAME
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
  
```

```

      sm_argument_id_s      : argument_id_s
    (INHERITED FROM DEF_NAME):
      lx_symrep             : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos             : source_position
      lx_comments           : comments
  
```

**** pragma_s**

```

    IS INCLUDED IN:
      SEQUENCES
      ALL_SOURCE
    NODE ATTRIBUTES:
      (NODE SPECIFIC):
        as_list             : Seq Of pragma
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos           : source_position
        lx_comments         : comments
    IS THE DECLARED TYPE OF:
      alignment.as_pragma_s
      compilation_unit.as_pragma_s
      labeled.as_pragma_s
      comp_list.as_pragma_s
  
```

**** PREDEF_NAME**

```

    CLASS MEMBERS:
      attribute_id
      void
      bltn_operator_id
      argument_id
      pragma_id
    IS INCLUDED IN:
      DEF_NAME
      ALL_SOURCE
    NODE ATTRIBUTES:
      (INHERITED FROM DEF_NAME):
        lx_symrep           *: symbol_rep
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos           : source_position
        lx_comments         : comments
    IS THE DECLARED TYPE OF:
      SUBPROG_NAME.sm_interface
  
```

**** private**

```

    IS INCLUDED IN:
      PRIVATE_SPEC
      DERIVABLE_SPEC
      TYPE_SPEC
    NODE ATTRIBUTES:
      (INHERITED FROM PRIVATE_SPEC):
        sm_discriminant_s   : dsccrmt_decl_s
        sm_type_spec        : TYPE_SPEC
  
```

```
(INHERITED FROM DERIVABLE_SPEC):  
    sm_derived      : TYPE_SPEC  
    sm_is_anonymous : Boolean
```

**** private_def**

```
IS INCLUDED IN:  
    TYPE_DEF  
    ALL_SOURCE  
NODE ATTRIBUTES:  
    (INHERITED FROM ALL_SOURCE):  
        lx_srcpos : source_position  
        lx_comments : comments
```

**** PRIVATE_SPEC**

```
CLASS MEMBERS:  
    private  
    i private  
IS INCLUDED IN:  
    DERIVABLE_SPEC  
    TYPE_SPEC  
NODE ATTRIBUTES:  
    (NODE SPECIFIC):  
        sm_discriminant_s : dscrmt_decl_s  
        sm_type_spec      : TYPE_SPEC  
    (INHERITED FROM DERIVABLE_SPEC):  
        sm_derived      : TYPE_SPEC  
        sm_is_anonymous : Boolean
```

**** private_type_id**

```
IS INCLUDED IN:  
    TYPE_NAME  
    SOURCE_NAME  
    DEF_NAME  
    ALL_SOURCE  
NODE ATTRIBUTES:  
    (INHERITED FROM TYPE_NAME):  
        sm_type_spec : TYPE_SPEC  
    (INHERITED FROM DEF_NAME):  
        lx_symrep : symbol_rep  
    (INHERITED FROM ALL_SOURCE):  
        lx_srcpos : source_position  
        lx_comments : comments
```

**** procedure_call**

```
IS INCLUDED IN:  
    CALL_STM  
    STM_WITH_NAME  
    STM  
    STM_ELEM  
    ALL_SOURCE
```

NODE ATTRIBUTES:

```
(INHERITED FROM CALL_STM):
  as_general_assoc_s : general_assoc_s
  sm_normalized_param_s : exp_s
(INHERITED FROM STM_WITH_NAME):
  as_name : NAME
(INHERITED FROM ALL_SOURCE):
  lx_srcpos : source_position
  lx_comments : comments
```

** procedure_id

IS INCLUDED IN:

```
SUBPROG_NAME
SUBPROG_PACK_NAME
NON_TASK_NAME
UNIT_NAME
SOURCE_NAME
DEF_NAME
ALL_SOURCE
```

NODE ATTRIBUTES:

```
(INHERITED FROM SUBPROG_NAME):
  sm_is_inline : Boolean
  sm_interface : PREDEF_NAME
(INHERITED FROM SUBPROG_PACK_NAME):
  sm_unit_desc : UNIT_DESC
  sm_address : EXP
(INHERITED FROM NON_TASK_NAME):
  sm_spec : HEADER
(INHERITED FROM UNIT_NAME):
  sm_first : DEF_NAME
(INHERITED FROM DEF_NAME):
  lx_symrep : symbol_rep
(INHERITED FROM ALL_SOURCE):
  lx_srcpos : source_position
  lx_comments : comments
```

** procedure_spec

IS INCLUDED IN:

```
SUBP_ENTRY_HEADER
HEADER
ALL_SOURCE
```

NODE ATTRIBUTES:

```
(INHERITED FROM SUBP_ENTRY_HEADER):
  as_param_s : param_s
(INHERITED FROM ALL_SOURCE):
  lx_srcpos : source_position
  lx_comments : comments
```

** QUAL_CONV

CLASS MEMBERS:

```
conversion
```

```

      qualified
IS INCLUDED IN:
      EXP_VAL_EXP
      EXP_VAL
      EXP_EXP
      EXP
      GENERAL ASSOC
      ALL SOURCE
NODE ATTRIBUTES:
      (NODE SPECIFIC):
          as_name                : NAME
      (INHERITED FROM EXP_VAL_EXP):
          as_exp                 : EXP
      (INHERITED FROM EXP_VAL):
          sm_value               : value
      (INHERITED FROM EXP_EXP):
          sm_exp_type            : TYPE_SPEC
      (INHERITED FROM ALL_SOURCE):
          lx_srcpos              : source_position
          lx_comments            : comments
  
```

** qualified

```

      IS INCLUDED IN:
          QUAL_CONV
          EXP_VAL_EXP
          EXP_VAL
          EXP_EXP
          EXP
          GENERAL ASSOC
          ALL SOURCE
NODE ATTRIBUTES:
      (INHERITED FROM QUAL_CONV):
          as_name                : NAME
      (INHERITED FROM EXP_VAL_EXP):
          as_exp                 : EXP
      (INHERITED FROM EXP_VAL):
          sm_value               : value
      (INHERITED FROM EXP_EXP):
          sm_exp_type            : TYPE_SPEC
      (INHERITED FROM ALL_SOURCE):
          lx_srcpos              : source_position
          lx_comments            : comments
IS THE DECLARED TYPE OF:
      qualified_allocator.as_qualified
  
```

** qualified_allocator

```

      IS INCLUDED IN:
          EXP_EXP
          EXP
          GENERAL ASSOC
          ALL SOURCE
NODE ATTRIBUTES:
  
```

```

(NODE SPECIFIC):
    as_qualified           : qualified
(INHERITED FROM EXP_EXP):
    sm_exp_type           : TYPE_SPEC
(INHERITED FROM ALL_SOURCE):
    lx_srcpos             : source_position
    lx_comments           : comments
  
```

**** raise**

```

IS INCLUDED IN:
    STM_WITH_NAME
    STM
    STM_ELEM
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM STM_WITH_NAME):
        as_name           : NAME
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos         : source_position
        lx_comments       : comments
  
```

**** RANGE**

```

CLASS MEMBERS:
    range
    void
    range_attribute
IS INCLUDED IN:
    DISCRETE_RANGE
    CONSTRAINT
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        sm_type_spec      : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos         : source_position
        lx_comments       : comments
IS THE DECLARED TYPE OF:
    comp_rep.as_range
    range_membership.as_range
    REAL_CONSTRAINT.as_range
    SCALAR.sm_range
  
```

**** range**

```

IS INCLUDED IN:
    RANGE
    DISCRETE_RANGE
    CONSTRAINT
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_exp1           : EXP
  
```

as_exp2	: EXP
(INHERITED FROM RANGE):	
sm_type_spec	: TYPE_SPEC
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

**** range_attribute**

IS INCLUDED IN:

RANGE
DISCRETE RANGE
CONSTRAINT
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_name	: NAME
as_exp	: EXP
as_used_name_id	: used_name_id

(INHERITED FROM RANGE):

sm_type_spec	: TYPE_SPEC
--------------	-------------

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

**** range_membership**

IS INCLUDED IN:

MEMBERSHIP
EXP_VAL_EXP
EXP_VAL
EXP_EXP
EXP
GENERAL ASSOC
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_range	: RANGE
----------	---------

(INHERITED FROM MEMBERSHIP):

as_membership_op	: MEMBERSHIP_OP
------------------	-----------------

(INHERITED FROM EXP_VAL_EXP):

as_exp	: EXP
--------	-------

(INHERITED FROM EXP_VAL):

sm_value	: value
----------	---------

(INHERITED FROM EXP_EXP):

sm_exp_type	: TYPE_SPEC
-------------	-------------

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

**** REAL**

CLASS MEMBERS:

float


```

    fixed
  IS INCLUDED IN:
    SCALAR
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_accuracy          : value
    (INHERITED FROM SCALAR):
      sm_range             : RANGE
      cd_impl_size         : Integer
    (INHERITED FROM NON_TASK):
      sm_base_type         : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived           : TYPE_SPEC
      sm_is_anonymous      : Boolean
  
```

**** REAL_CONSTRAINT**

```

  CLASS MEMBERS:
    float_constraint
    fixed_constraint
  IS INCLUDED IN:
    CONSTRAINT
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_type_spec         : TYPE_SPEC
      as_exp               : EXP
      as_range             : RANGE
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos            : source_position
      lx_comments          : comments
  
```

**** record**

```

  IS INCLUDED IN:
    UNCONSTRAINED_COMPOSITE
    UNCONSTRAINED
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_discriminant_s    : dscrmt_decl_s
      sm_representation    : REP
      sm_comp_list         : comp_list
    (INHERITED FROM UNCONSTRAINED_COMPOSITE):
      sm_is_limited        : Boolean
      sm_is_packed         : Boolean
    (INHERITED FROM UNCONSTRAINED):
  
```

```

      sm_size                : EXP
    (INHERITED FROM NON_TASK):
      sm_base_type           : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived              : TYPE_SPEC
      sm_is_anonymous         : Boolean
  
```

**** record_def**

```

    IS INCLUDED IN:
      TYPE_DEF
      ALL_SOURCE
    NODE ATTRIBUTES:
      (NODE SPECIFIC):
        as_comp_list         : comp_list
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos            : source_position
        lx_comments          : comments
  
```

**** record_rep**

```

    IS INCLUDED IN:
      REP
      DECL
      ITEM
      ALL_DECL
      ALL_SOURCE
    NODE ATTRIBUTES:
      (NODE SPECIFIC):
        as_alignment_clause  : ALIGNMENT_CLAUSE
        as_comp_rep_s        : comp_rep_s
      (INHERITED FROM REP):
        as_name               : NAME
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos            : source_position
        lx_comments          : comments
  
```

**** RENAME_INSTANT**

```

    CLASS MEMBERS:
      renames_unit
      instantiation
    IS INCLUDED IN:
      UNIT_KIND
      UNIT_DESC
      ALL_SOURCE
    NODE ATTRIBUTES:
      (NODE SPECIFIC):
        as_name               : NAME
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos            : source_position
        lx_comments          : comments
  
```

**** renames_exc_decl**

```
IS INCLUDED IN:
    SIMPLE_RENAME_DECL
    ID_DECL
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM SIMPLE_RENAME_DECL):
        as_name : NAME
    (INHERITED FROM ID_DECL):
        as_source_name : SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos : source_position
        lx_comments : comments
```

** renames_obj_decl

```
IS INCLUDED IN:
    SIMPLE_RENAME_DECL
    ID_DECL
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_type_mark_name : NAME
    (INHERITED FROM SIMPLE_RENAME_DECL):
        as_name : NAME
    (INHERITED FROM ID_DECL):
        as_source_name : SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos : source_position
        lx_comments : comments
```

** renames_unit

```
IS INCLUDED IN:
    RENAME_INSTANT
    UNIT_KIND
    UNIT_DESC
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM RENAME_INSTANT):
        as_name : NAME
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos : source_position
        lx_comments : comments
```

** REP

CLASS MEMBERS:

```

    void
    NAMED_REP
    record_rep
    length_enum_rep
    address
  IS INCLUDED IN:
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_name : NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  IS THE DECLARED TYPE OF:
    record.sm_representation

```

**** return**

```

  IS INCLUDED IN:
    STM_WITH_EXP
    STM
    STM_ELEM
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM STM_WITH_EXP):
      as_exp : EXP
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

```

**** reverse**

```

  IS INCLUDED IN:
    FOR_REV
    ITERATION
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM FOR_REV):
      as_source_name : SOURCE_NAME
      as_discrete_range : DISCRETE_RANGE
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

```

**** SCALAR**

```

  CLASS MEMBERS:
    enumeration
    REAL
    integer
    float

```

```

    fixed
  IS INCLUDED IN:
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_range                : RANGE
      cd_impl_size            : Integer
    (INHERITED FROM NON_TASK):
      sm_base_type            : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived              : TYPE_SPEC
      sm_is_anonymous         : Boolean
  IS THE DECLARED TYPE OF:
    scalar_s.as_list [Seq Of]
  
```

**** scalar_s**

```

  IS INCLUDED IN:
    SEQUENCES
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_list                 : Seq Of SCALAR
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos               : source_position
      lx_comments             : comments
  IS THE DECLARED TYPE OF:
    constrained_array.sm_index_subtype_s
  
```

**** select_alt_pragma**

```

  IS INCLUDED IN:
    TEST_CLAUSE_ELEM
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_pragma               : pragma
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos               : source_position
      lx_comments             : comments
  
```

**** select_alternative**

```

  IS INCLUDED IN:
    TEST_CLAUSE
    TEST_CLAUSE_ELEM
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM TEST_CLAUSE):
      as_exp                  : EXP
      as_stm_s                : stm_s
  
```

```
(INHERITED FROM ALL_SOURCE):
    lx_srcpos      : source_position
    lx_comments    : comments
```

**** selected**

```
IS INCLUDED IN:
    NAME_VAL
    NAME_EXP
    NAME
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_designator      : DESIGNATOR
    (INHERITED FROM NAME_VAL):
        sm_value           : value
    (INHERITED FROM NAME_EXP):
        as_name            : NAME
        sm_exp_type        : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos          : source_position
        lx_comments        : comments
```

**** selective_wait**

```
IS INCLUDED IN:
    CLAUSES_STM
    STM
    STM_ELEM
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM CLAUSES_STM):
        as_test_clause_elem_s : test_clause_elem_s
        as_stm_s              : stm_s
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos             : source_position
        lx_comments           : comments
```

**** SEQUENCES**

```
CLASS MEMBERS:
    alternative_s
    variant_s
    use_pragma_s
    test_clause_elem_s
    stm_s
    source_name_s
    scalar_s
    pragma_s
    param_s
    name_s
    index_s
```

```

    item_s
    exp_s
    enum_literal_s
    discrete_range_s
    general_assoc_s
    dscrmt_decl_s
    decl_s
    context_elem_s
    compltn_unit_s
    comp_rep_s
    choice_s
    argument_id_s
  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos      : source_position
      lx_comments    : comments

```

** short_circuit

```

  IS INCLUDED IN:
    EXP_VAL
    EXP_EXP
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_exp1      : EXP
      as_exp2      : EXP
      as_short_circuit_op : SHORT_CIRCUIT_OP
    (INHERITED FROM EXP_VAL):
      sm_value     : value
    (INHERITED FROM EXP_EXP):
      sm_exp_type  : TYPE_SPEC
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos    : source_position
      lx_comments  : comments

```

** SHORT_CIRCUIT_OP

```

  CLASS MEMBERS:
    and_then
    or_else
  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos    : source_position
      lx_comments  : comments
  IS THE DECLARED TYPE OF:
    short_circuit.as_short_circuit_op

```

** SIMPLE_RENAME_DECL

CLASS MEMBERS:

renames_obj_decl
 renames_exc_decl

IS INCLUDED IN:

ID_DECL
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_name

: NAME

(INHERITED FROM ID_DECL):

as_source_name

: SOURCE_NAME

(INHERITED FROM ALL_SOURCE):

lx_srcpos

: source_position

lx_comments

: comments

** slice

IS INCLUDED IN:

NAME_EXP
 NAME_
 EXP
 GENERAL ASSOC
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_discrete_range

: DISCRETE_RANGE

(INHERITED FROM NAME_EXP):

as_name

: NAME

sm_exp_type

: TYPE_SPEC

(INHERITED FROM ALL_SOURCE):

lx_srcpos

: source_position

lx_comments

: comments

** SOURCE_NAME

CLASS MEMBERS:

OBJECT_NAME
 LABEL_NAME
 UNIT_NAME
 TYPE_NAME
 void
 entry_id
 exception_id
 INIT_OBJECT_NAME
 ENUM_LITERAL
 iteration_id
 label_id
 block_loop_id
 NON_TASK_NAME


```

    task_body_id
    type_id
    subtype_id
    private_type_id
    l_private_type_id
    VC_NAME
    number_id
    COMP_NAME
    PARAM_NAME
    enumeration_id
    character_id
    SUBPROG_PACK_NAME
    generic_id
    variable_id
    constant_id
    component_id
    discriminant_id
    in_id
    out_id
    in_out_id
    SUBPROG_NAME
    package_id
    procedure_id
    operator_id
    function_id
  IS INCLUDED IN:
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM DEF_NAME):
      lx_symrep : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments
  IS THE DECLARED TYPE OF:
    SUBUNIT_BODY.as_source_name
    implicit_not_eq.sm_equal
    derived_subprog.sm_derivable
    FOR_REV.as_source_name
    BLOCK_LOOP.as_source_name
    source_name_s.as_list [Seq Of]
    ID_DECL.as_source_name

```

** source_name_s

```

  IS INCLUDED IN:
    SEQUENCES
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_list : Seq Of SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

```

IS THE DECLARED TYPE OF:

labeled.as_source_name_s
DSCRMT_PARAM_DECL.as_source_name_s
ID_S_DECL.as_source_name_s

** STM

CLASS MEMBERS:

labeled
null_stm
abort
STM_WITH_EXP
STM_WITH_NAME
accept
ENTRY_STM
BLOCK_LOOP
CLAUSES_STM
terminate
return
delay
STM_WITH_EXP_NAME
case
goto
raise
CALL_STM
cond_entry
timed_entry
loop
block
if
selective_wait
assign
code
exit
entry_call
procedure_call

IS INCLUDED IN:

STM_ELEM
ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
lx_comments : comments

IS THE DECLARED TYPE OF:

block_master.sm_stm
exit.sm_stm
LABEL_NAME.sm_stm
labeled.as_stm

** STM_ELEM

CLASS MEMBERS:

STM
stm_pragma

```

    labeled
    null_stm.
    abort
    STM_WITH_EXP
    STM_WITH_NAME
    accept
    ENTRY_STM
    BLOCK_LOOP
    CLAUSES_STM
    terminate
    return
    delay
    STM_WITH_EXP_NAME
    case
    goto
    raise
    CALL_STM
    cond_entry
    timed_entry
    loop
    block
    if
    selective_wait
    assign
    code
    exit
    entry_call
    procedure_call
  IS INCLUDED IN:
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos      : source_position
      lx_comments    : comments
  IS THE DECLARED TYPE OF:
    stm_s.as_list [Seq Of]

```

** stm_pragma

```

  IS INCLUDED IN:
    STM_ELEM
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_pragma      : pragma
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos      : source_position
      lx_comments    : comments

```

** stm_s

```

  IS INCLUDED IN:
    SEQUENCES
    ALL_SOURCE

```

NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of STM_ELEM
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 ENTRY_STM.as_stm_s1
 .as_stm_s2
 accept.as_stm_s
 block_body.as_stm_s
 loop.as_stm_s
 alternative.as_stm_s
 TEST_CLAUSE.as_stm_s
 CLAUSES_STM.as_stm_s

** STM_WITH_EXP

CLASS MEMBERS:
 return
 delay
 STM_WITH_EXP_NAME
 case
 assign
 code
 exit
 IS INCLUDED IN:
 STM
 STM_ELEM
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_exp : EXP
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** STM_WITH_EXP_NAME

CLASS MEMBERS:
 assign
 code
 exit
 IS INCLUDED IN:
 STM_WITH_EXP
 STM
 STM_ELEM
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_name : NAME
 (INHERITED FROM STM_WITH_EXP):
 as_exp : EXP
 (INHERITED FROM ALL_SOURCE):

1x_srcpos	: source_position
1x_comments	: comments

** STM_WITH_NAME

CLASS MEMBERS:

goto
 raise
 CALL_STM
 entry_call
 procedure_call

IS INCLUDED IN:

STM
 STM_ELEM
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_name	: NAME
---------	--------

(INHERITED FROM ALL_SOURCE):

1x_srcpos	: source_position
1x_comments	: comments

** string_literal

IS INCLUDED IN:

AGG_EXP
 EXP_EXP
 EXP
 GENERAL ASSOC
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

1x_symrep	: symbol_rep
-----------	--------------

(INHERITED FROM AGG_EXP):

sm_discrete_range	: DISCRETE_RANGE
-------------------	------------------

(INHERITED FROM EXP_EXP):

sm_exp_type	: TYPE_SPEC
-------------	-------------

(INHERITED FROM ALL_SOURCE):

1x_srcpos	: source_position
1x_comments	: comments

** stub

IS INCLUDED IN:

BODY
 UNIT_DESC
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

1x_srcpos	: source_position
1x_comments	: comments

** SUBP_ENTRY_HEADER

```

CLASS MEMBERS:
    procedure_spec
    function_spec
    entry
IS INCLUDED IN:
    HEADER
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        as_param_s           : param_s
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos            : source_position
        lx_comments          : comments
  
```

**** subprog_entry_decl**

```

IS INCLUDED IN:
    NON_GENERIC_DECL
    UNIT_DECL
    ID_DECL
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM NON_GENERIC_DECL):
        as_unit_kind         : UNIT_KIND
    (INHERITED FROM UNIT_DECL):
        as_header            : HEADER
    (INHERITED FROM ID_DECL):
        as_source_name       : SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos            : source_position
        lx_comments          : comments
  
```

**** SUBPROG_NAME**

```

CLASS MEMBERS:
    procedure_id
    operator_id
    function_id
IS INCLUDED IN:
    SUBPROG_PACK_NAME
    NON_TASK_NAME
    UNIT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        sm_is_inline         : Boolean
        sm_interface         : PREDEF_NAME
    (INHERITED FROM SUBPROG_PACK_NAME):
        sm_unit_desc         : UNIT_DESC
  
```

```

      sm_address      : EXP
    (INHERITED FROM NON_TASK_NAME):
      sm_spec        : HEADER
    (INHERITED FROM UNIT_NAME):
      sm_first       : DEF_NAME
    (INHERITED FROM DEF_NAME):
      lx_symrep      : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos      : source_position
      lx_comments    : comments
  
```

**** SUBPROG_PACK_NAME**

CLASS MEMBERS:

```

    SUBPROG_NAME
    package_id
    procedure_id
    operator_id
    function_id
  
```

IS INCLUDED IN:

```

    NON_TASK_NAME
    UNIT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  
```

NODE ATTRIBUTES:

(NODE SPECIFIC):

```

      sm_unit_desc   : UNIT_DESC
      sm_address     : EXP
    (INHERITED FROM NON_TASK_NAME):
      sm_spec        : HEADER
    (INHERITED FROM UNIT_NAME):
      sm_first       : DEF_NAME
    (INHERITED FROM DEF_NAME):
      lx_symrep      : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos      : source_position
      lx_comments    : comments
  
```

**** subprogram_body**

IS INCLUDED IN:

```

    SUBUNIT_BODY
    ITEM
    ALL_DECL
    ALL_SOURCE
  
```

NODE ATTRIBUTES:

(NODE SPECIFIC):

```

      as_header      : HEADER
    (INHERITED FROM SUBUNIT_BODY):
      as_source_name : SOURCE_NAME
      as_body        : BODY
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos      : source_position
  
```

lx_comments : comments

**** subtype_allocator**

IS INCLUDED IN:

EXP_EXP

EXP

GENERAL ASSOC

ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_subtype_indication : subtype_indication

sm_design_type : TYPE_SPEC

(INHERITED FROM EXP_EXP):

sm_exp_type : TYPE_SPEC

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

**** subtype_decl**

IS INCLUDED IN:

ID_DECL

DECL

ITEM

ALL_DECL

ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_subtype_indication : subtype_indication

(INHERITED FROM ID_DECL):

as_source_name : SOURCE_NAME

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

**** subtype_id**

IS INCLUDED IN:

TYPE_NAME

SOURCE_NAME

DEF_NAME

ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM TYPE_NAME):

sm_type_spec : TYPE_SPEC

(INHERITED FROM DEF_NAME):

lx_symrep : symbol_rep

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

**** subtype_indication**

IS INCLUDED IN:
 CONSTRAINED_DEF
 TYPE_DEF
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_name : NAME
 (INHERITED FROM CONSTRAINED_DEF):
 as_constraint : CONSTRAINT
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 subtype_allocator.as_subtype_indication
 discrete_subtype.as_subtype_indication
 subtype_decl.as_subtype_indication
 ARR_ACC_DER_DEF.as_subtype_indication

** subunit

IS INCLUDED IN:
 ALL_DECL
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_name : NAME
 as_subunit_body : SUBUNIT_BODY
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

** SUBUNIT_BODY

CLASS MEMBERS:
 subprogram_body
 task_body
 package_body
IS INCLUDED IN:
 ITEM
 ALL_DECL
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_source_name : SOURCE_NAME
 as_body : BODY
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 subunit.as_subunit_body

** task_body

IS INCLUDED IN:

```

    SUBUNIT_BODY
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (INHERITED FROM SUBUNIT_BODY):
      as_source_name      : SOURCE_NAME
      as_body             : BODY
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos           : source_position
      lx_comments         : comments

** task_body_id

  IS INCLUDED IN:
    UNIT_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_type_spec        : TYPE_SPEC
      sm_body             : BODY
    (INHERITED FROM UNIT_NAME):
      sm_first            : DEF_NAME
    (INHERITED FROM DEF_NAME):
      lx_symrep           : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos           : source_position
      lx_comments         : comments

** task_decl

  IS INCLUDED IN:
    ID_DECL
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_decl_s           : decl_s
    (INHERITED FROM ID_DECL):
      as_source_name      : SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos           : source_position
      lx_comments         : comments

** task_spec

  IS INCLUDED IN:
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC

```

NODE ATTRIBUTES:
 (NODE SPECIFIC):
 sm_decl_s : decl_s
 sm_storage_size : EXP
 sm_size : EXP
 sm_address : EXP
 sm_body : BODY
 (INHERITED FROM DERIVABLE_SPEC):
 sm_derived : TYPE_SPEC
 sm_is_anonymous : Boolean

**** terminate**

IS INCLUDED IN:
 STM
 STM_ELEM
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** TEST_CLAUSE**

CLASS MEMBERS:
 cond_clause
 select_alternative
IS INCLUDED IN:
 TEST_CLAUSE_ELEM
 ALL_SOURCE
NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_exp : EXP
 as_stm_s : stm_s
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** TEST_CLAUSE_ELEM**

CLASS MEMBERS:
 TEST_CLAUSE
 select_alt_pragma
 cond_clause
 select_alternative
IS INCLUDED IN:
 ALL_SOURCE
NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 test_clause_elem_s.as_list [Seq Of]

**** test_clause_elem_s**

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of TEST_CLAUSE_ELEM
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 CLAUSES_STM.as_test_clause_elem_s

**** timed_entry**

IS INCLUDED IN:
 ENTRY_STM
 STM
 STM_ELEM
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM ENTRY_STM):
 as_stm_s1 : stm_s
 as_stm_s2 : stm_s
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** type_decl**

IS INCLUDED IN:
 ID_DECL
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_dscrmt_decl_s : dscrmt_decl_s
 as_type_def : TYPE_DEF
 (INHERITED FROM ID_DECL):
 as_source_name : SOURCE_NAME
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** TYPE_DEF**

CLASS MEMBERS:
 enumeration_def
 record_def
 ARR_ACC_DER_DEF
 CONSTRAINED_DEF

```

void
private_def
l_private_def
formal_dscrt_def
formal_float_def
formal_fixed_def
formal_integer_def
constrained_array_def
derived_def
access_def
unconstrained_array_def
subtype_indication
integer_def
fixed_def
float_def
IS INCLUDED IN:
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos      : source_position
        lx_comments    : comments
IS THE DECLARED TYPE OF:
    type_decl.as_type_def
    OBJECT_DECL.as_type_def

```

**** type_id**

```

IS INCLUDED IN:
    TYPE_NAME
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
NODE ATTRIBUTES:
    (NODE SPECIFIC):
        sm_first      : DEF_NAME
    (INHERITED FROM TYPE_NAME):
        sm_type_spec  : TYPE_SPEC
    (INHERITED FROM DEF_NAME):
        lx_symrep     : symbol_rep
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos     : source_position
        lx_comments   : comments

```

**** type_membership**

```

IS INCLUDED IN:
    MEMBERSHIP
    EXP_VAL_EXP
    EXP_VAL
    EXP_EXP
    EXP
    GENERAL_ASSOC
    ALL_SOURCE
NODE ATTRIBUTES:

```

(NODE SPECIFIC):	
as_name	: NAME
(INHERITED FROM MEMBERSHIP):	
as_membership_op	: MEMBERSHIP_OP
(INHERITED FROM EXP_VAL_EXP):	
as_exp	: EXP
(INHERITED FROM EXP_VAL):	
sm_value	: value
(INHERITED FROM EXP_EXP):	
sm_exp_type	: TYPE_SPEC
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

** TYPE_NAME

CLASS MEMBERS:

type_id
subtype_id
private_type_id
l private_type_id

IS INCLUDED IN:

SOURCE_NAME
DEF_NAME
ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):	
sm_type_spec	: TYPE_SPEC
(INHERITED FROM DEF_NAME):	
lx_symrep	: symbol_rep
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

** TYPE_SPEC

CLASS MEMBERS:

DERIVABLE_SPEC
incomplete
void
universal_integer
universal_real
universal_fixed
FULL_TYPE_SPEC
PRIVATE_SPEC
task_spec
NON_TASK
private
l private
SCALAR
CONSTRAINED
UNCONSTRAINED
enumeration
REAL

```
integer
constrained_array
constrained_access
constrained_record
UNCONSTRAINED_COMPOSITE
access
float
fixed
array
record
IS THE DECLARED TYPE OF:
task_body_id.sm_type_spec
PRIVATE_SPEC.sm_type_spec
subtype_allocator.sm_desig_type
EXP_EXP.sm_exp_type
USED_OBJECT.sm_exp_type
NAME_EXP.sm_exp_type
constrained_access.sm_desig_type
access.sm_desig_type
index.sm_type_spec
array.sm_comp_type
REAL_CONSTRAINT.sm_type_spec
RANGE.sm_type_spec
NON_TASK.sm_base_type
DERIVABLE_SPEC.sm_derived
TYPE_NAME.sm_type_spec
OBJECT_NAME.sm_obj_type
```

** UNCONSTRAINED

```
CLASS MEMBERS:
UNCONSTRAINED_COMPOSITE
access
array
record
IS INCLUDED IN:
NON_TASK
FULL_TYPE_SPEC
DERIVABLE_SPEC
TYPE_SPEC
NODE ATTRIBUTES:
(NODE SPECIFIC):
    sm_size : EXP
(INHERITED FROM NON_TASK):
    sm_base_type : TYPE_SPEC
(INHERITED FROM DERIVABLE_SPEC):
    sm_derived : TYPE_SPEC
    sm_is_anonymous : Boolean
```

** unconstrained_array_def

```
IS INCLUDED IN:
ARR_ACC_DER_DEF
TYPE_DEF
```

```

    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_index_s          : index_s
    (INHERITED FROM ARR_ACC_DER_DEF):
      as_subtype_indication : subtype_indication
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos           : source_position
      lx_comments         : comments
  
```

** UNCONSTRAINED_COMPOSITE

```

  CLASS MEMBERS:
    array
    record
  IS INCLUDED IN:
    UNCONSTRAINED
    NON_TASK
    FULL_TYPE_SPEC
    DERIVABLE_SPEC
    TYPE_SPEC
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_is_limited      : Boolean
      sm_is_packed       : Boolean
    (INHERITED FROM UNCONSTRAINED):
      sm_size            : EXP
    (INHERITED FROM NON_TASK):
      sm_base_type       : TYPE_SPEC
    (INHERITED FROM DERIVABLE_SPEC):
      sm_derived         : TYPE_SPEC
      sm_is_anonymous    : Boolean
  
```

** UNIT_DECL

```

  CLASS MEMBERS:
    generic_decl
    NON_GENERIC_DECL
    subprog_entry_decl
    package_decl
  IS INCLUDED IN:
    ID_DECL
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_header          : HEADER
    (INHERITED FROM ID_DECL):
      as_source_name     : SOURCE_NAME
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos          : source_position
      lx_comments        : comments
  
```


**** UNIT_DESC**

```
CLASS MEMBERS:
    UNIT_KIND
    derived_subprog
    implicit_not_eq
    BODY
    void
    RENAME_INSTANT
    GENERIC_PARAM
    block_body
    stub
    renames_unit
    instantiation
    name_default
    no_default
    box_default
IS INCLUDED IN:
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos      : source_position
        lx_comments    : comments
IS THE DECLARED TYPE OF:
    SUBPROG_PACK_NAME.sm_unit_desc
```

**** UNIT_KIND**

```
CLASS MEMBERS:
    void
    RENAME_INSTANT
    GENERIC_PARAM
    renames_unit
    instantiation
    name_default
    no_default
    box_default
IS INCLUDED IN:
    UNIT_DESC
    ALL_SOURCE
NODE ATTRIBUTES:
    (INHERITED FROM ALL_SOURCE):
        lx_srcpos      : source_position
        lx_comments    : comments
IS THE DECLARED TYPE OF:
    NON_GENERIC_DECL.as_unit_kind
```

**** UNIT_NAME**

```
CLASS MEMBERS:
    NON_TASK_NAME
    task_body_id
    SUBPROG_PACK_NAME
```

```

    generic_id
    SUBPROG_NAME
    package_id
    procedure_id
    operator_id
    function_id
  IS INCLUDED IN:
    SOURCE_NAME
    DEF_NAME
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      sm_first : DEF_NAME
    (INHERITED FROM DEF_NAME):
      lx_symrep : symbol_rep
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

** universal_fixed

  IS INCLUDED IN:
    TYPE_SPEC
  NODE ATTRIBUTES:

** universal_integer

  IS INCLUDED IN:
    TYPE_SPEC
  NODE ATTRIBUTES:

** universal_real

  IS INCLUDED IN:
    TYPE_SPEC
  NODE ATTRIBUTES:

** use

  IS INCLUDED IN:
    USE_PRAGMA
    DECL
    ITEM
    ALL_DECL
    ALL_SOURCE
  NODE ATTRIBUTES:
    (NODE SPECIFIC):
      as_name_s : name_s
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos : source_position
      lx_comments : comments

** USE_PRAGMA

```

CLASS MEMBERS:

use
 pragma

IS INCLUDED IN:

DECL
 ITEM
 ALL_DECL
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
 lx_comments : comments

IS THE DECLARED TYPE OF:

use_pragma_s.as_list [Seq Of]

** use_pragma_s

IS INCLUDED IN:

SEQUENCES
 ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_list : Seq Of USE_PRAGMA

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
 lx_comments : comments

IS THE DECLARED TYPE OF:

with.as_use_pragma_s

** used_char

IS INCLUDED IN:

USED_OBJECT
 DESIGNATOR
 NAME
 EXP
 GENERAL_ASSOC
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM USED_OBJECT):

sm_exp_type : TYPE_SPEC
 sm_value : value

(INHERITED FROM DESIGNATOR):

sm_defn : DEF_NAME
 lx_symrep : symbol_rep

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position
 lx_comments : comments

** USED_NAME

CLASS MEMBERS:

used_op
 used_name_id

IS INCLUDED IN:
DESIGNATOR
NAME
EXP
GENERAL ASSOC
ALL_SOURCE
NODE ATTRIBUTES:
(INHERITED FROM DESIGNATOR):
 sm_defn : DEF_NAME
 lx_symrep : symbol_rep
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 assoc.as_used_name

** used_name_id

IS INCLUDED IN:
USED NAME
DESIGNATOR
NAME
EXP
GENERAL ASSOC
ALL_SOURCE
NODE ATTRIBUTES:
(INHERITED FROM DESIGNATOR):
 sm_defn : DEF_NAME
 lx_symrep : symbol_rep
(INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
IS THE DECLARED TYPE OF:
 attribute.as_used_name_id
 range_attribute.as_used_name_id
 pragma.as_used_name_id

** USED_OBJECT

CLASS MEMBERS:
 used_char
 used_object_id
IS INCLUDED IN:
DESIGNATOR
NAME
EXP
GENERAL ASSOC
ALL_SOURCE
NODE ATTRIBUTES:
(NODE SPECIFIC):
 sm_exp_type : TYPE_SPEC
 sm_value : value
(INHERITED FROM DESIGNATOR):
 sm_defn : DEF_NAME

lx_symrep	: symbol_rep
(INHERITED FROM ALL_SOURCE):	
lx_srcpos	: source_position
lx_comments	: comments

** used_object_id

IS INCLUDED IN:

USED_OBJECT
 DESIGNATOR
 NAME
 EXP
 GENERAL_ASSOC
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM USED_OBJECT):

sm_exp_type	: TYPE_SPEC
sm_value	: value

(INHERITED FROM DESIGNATOR):

sm_defn	: DEF_NAME
lx_symrep	: symbol_rep

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

** used_op

IS INCLUDED IN:

USED_NAME
 DESIGNATOR
 NAME
 EXP
 GENERAL_ASSOC
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM DESIGNATOR):

sm_defn	: DEF_NAME
lx_symrep	: symbol_rep

(INHERITED FROM ALL_SOURCE):

lx_srcpos	: source_position
lx_comments	: comments

** variable_decl

IS INCLUDED IN:

OBJECT_DECL
 EXP_DECL
 ID_S_DECL
 DECL
 ITEM
 ALL_DECL
 ALL_SOURCE

NODE ATTRIBUTES:

(INHERITED FROM OBJECT_DECL):

```

      as_type_def          : TYPE_DEF
    (INHERITED FROM EXP_DECL):
      as_exp              : EXP
    (INHERITED FROM ID_S_DECL):
      as_source_name_s    : source_name_s
    (INHERITED FROM ALL_SOURCE):
      lx_srcpos           : source_position
      lx_comments         : comments
  
```

** variable_id

```

    IS INCLUDED IN:
      VC_NAME
      INIT_OBJECT_NAME
      OBJECT_NAME
      SOURCE_NAME
      DEF_NAME
      ALL_SOURCE
    NODE ATTRIBUTES:
      (NODE SPECIFIC):
        sm_is_shared      : Boolean
      (INHERITED FROM VC_NAME):
        sm_renames_obj    : Boolean
        sm_address        : EXP
      (INHERITED FROM INIT_OBJECT_NAME):
        sm_init_exp       : EXP
      (INHERITED FROM OBJECT_NAME):
        sm_obj_type       : TYPE_SPEC
      (INHERITED FROM DEF_NAME):
        lx_symrep         : symbol_rep
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos         : source_position
        lx_comments       : comments
  
```

** variant

```

    IS INCLUDED IN:
      VARIANT_ELEM
      ALL_SOURCE
    NODE ATTRIBUTES:
      (NODE SPECIFIC):
        as_choice_s       : choice_s
        as_comp_list      : comp_list
      (INHERITED FROM ALL_SOURCE):
        lx_srcpos         : source_position
        lx_comments       : comments
  
```

** VARIANT_ELEM

```

    CLASS MEMBERS:
      variant
      variant_pragma
    IS INCLUDED IN:
      ALL_SOURCE
  
```

NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 variant_s.as_list [Seq Of]

**** VARIANT_PART**

CLASS MEMBERS:
 variant_part
 void
 IS INCLUDED IN:
 ALL_SOURCE
 NODE ATTRIBUTES:
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments
 IS THE DECLARED TYPE OF:
 comp_list.as_variant_part

**** variant_part**

IS INCLUDED IN:
 VARIANT_PART
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_name : NAME
 as_variant_s : variant_s
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** variant_pragma**

IS INCLUDED IN:
 VARIANT_ELEM
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_pragma : pragma
 (INHERITED FROM ALL_SOURCE):
 lx_srcpos : source_position
 lx_comments : comments

**** variant_s**

IS INCLUDED IN:
 SEQUENCES
 ALL_SOURCE
 NODE ATTRIBUTES:
 (NODE SPECIFIC):
 as_list : Seq Of VARIANT_ELEM

```

      (INHERITED FROM ALL_SOURCE):
          lx_srcpos      : source_position
          lx_comments    : comments
  IS THE DECLARED TYPE OF:
      variant_part.as_variant_s

```

** VC_NAME

```

  CLASS MEMBERS:
      variable_id
      constant_id
  IS INCLUDED IN:
      INIT_OBJECT_NAME
      OBJECT_NAME
      SOURCE_NAME
      DEF_NAME
      ALL_SOURCE
  NODE ATTRIBUTES:
      (NODE SPECIFIC):
          sm_renames_obj : Boolean
          sm_address     : EXP
      (INHERITED FROM INIT_OBJECT_NAME):
          sm_init_exp    : EXP
      (INHERITED FROM OBJECT_NAME):
          sm_obj_type    : TYPE_SPEC
      (INHERITED FROM DEF_NAME):
          lx_symrep      : symbol_rep
      (INHERITED FROM ALL_SOURCE):
          lx_srcpos      : source_position
          lx_comments    : comments

```

** void

```

  IS INCLUDED IN:
      PREDEF_NAME
      COMP_REP_ELEM
      ALIGNMENT_CLAUSE
      ALL_DECL
      BODY
      UNIT_KIND
      NAME
      ITERATION
      SOURCE_NAME
      TYPE_SPEC
      TYPE_DEF
      VARIANT_PART
      REP
      RANGE
      CONSTRAINT
      EXP
      DEF_NAME
      ALL_SOURCE
      UNIT_DESC
      DECL

```


DISCRETE_RANGE
 GENERAL_ASSOC
 ITEM

NODE ATTRIBUTES:

(INHERITED FROM REP):

as_name : NAME

(INHERITED FROM RANGE):

sm_type_spec : TYPE_SPEC

(INHERITED FROM DEF_NAME):

lx_symrep : symbol_rep

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

** while

IS INCLUDED IN:

ITERATION

ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_exp : EXP

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

** with

IS INCLUDED IN:

CONTEXT_ELEM

ALL_SOURCE

NODE ATTRIBUTES:

(NODE SPECIFIC):

as_name_s : name_s

as_use_pragma_s : use_pragma_s

(INHERITED FROM ALL_SOURCE):

lx_srcpos : source_position

lx_comments : comments

APPENDIX B

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